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Instructor's Manual for Mine Rescue Training

Training Module–Mine Rescue

U.S. Department of Labor
Mine Safety and Health Administration
Education and Training Directorate
November 1981

MSHA 2001

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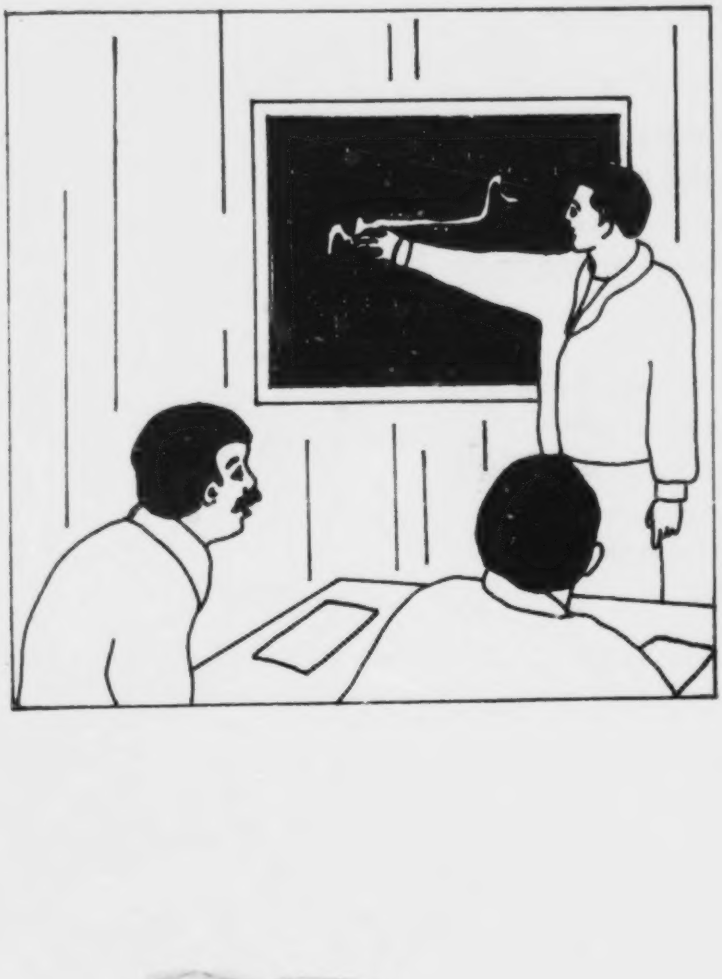

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ABOUT THE TRAINING MODULES:

The modules are designed to implement the training of the Nation's mine rescue team members as mandated by Part 49, Subchapter H, Chapter 1, Title 30, Code of Federal Regulations pursuant to the Mine Safety and Health Act of 1977. Each of the modules covers a separate subject in a self-contained unit with suggested handouts and visual material to aid in its presentation. They are designed specifically for the training of underground inexperienced or experienced mine rescue team members.

Training module MSHA 2001, Instructor's Manual for Mine Rescue Training, contains a list of modules in the training program as well as a glossary that can be useful to the instructor.

This program was developed by the Mining Extension Service of West Virginia University for the Mine Safety and Health Administration under United States Bureau of Mines Contract Number JO308002.

Instructor's Manual for Mine Rescue Training

Training Module–Mine Rescue

U.S. Department of Labor
Raymond J. Donovan, Secretary

Mine Safety and Health Administration
November 1981

MSHA 2001

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Introduction

On July 11, 1981 the Federal Government enacted laws (Part 49, 30 *CFR*) to assure that all underground mines have mine rescue teams available to them in the event of an emergency. The materials provided in this package are intended to aid instructors in training mine rescue teams.

These materials have been designed in accordance with the Federal requirements for team training under Part 49 of 30 *CFR*. The materials are divided into two parts:

1. Initial training to satisfy the requirement for 20 hours of instruction on the use, care, and maintenance of the team's breathing apparatus (for newly formed teams only or for teams going to a new apparatus).

2. Advanced/Refresher training to satisfy the requirement for at least 40 hours of refresher training annually.

The Instructor's Role

You are about to assume an important responsibility - that of building and maintaining a capable mine rescue team. What the team members learn during these training sessions could very well help to save a miner's life, and even one's own life. Keep this in mind as you proceed, and be sure to let the team members know that this program was developed with their health and safety in mind.

These training materials have been designed to be as complete and self-contained as possible so that everything you might need to teach is included. Nevertheless, you do not have to teach everything presented. *Be flexible and tailor the material to the needs of your team.* This might mean omitting some sections on a subject the team already knows, or it might mean spending more time on other subjects. Or you may use the material simply as a reference for a more personalized lecture or lesson which you could prepare on your own.

Before you teach each module it's important to sit down and study the module so you'll be familiar with what you'll be teaching. You may wish to highlight or underline certain points that you want to stress during the lecture. Or you might want to add notes of your own in the margins (plenty of room has been left for this purpose). You should also consider how you are going to present each visual. Some visuals may work best as handouts, some as overhead transparencies. The key to delivering a good lecture is to be familiar and comfortable with the material.

The Training Modules

The training material in this mine rescue series was prepared to help you teach easily and effectively. The training program is broken into self-contained units of study called "modules," each of which covers a separate subject.

The modules provided in this training series include:

Initial Training	MSHA 2002	Introduction to Mine Rescue
	MSHA 2003	Introduction to Self-Contained Breathing Apparatus
	MSHA 2004	Draeger BG 174-A
	MSHA 2005	Aerorlox
	MSHA 2006	McCaa
	MSHA 2007	Scott Rescue-Pak
	MSHA 2008	Introduction to Auxiliary Apparatus
	MSHA 2009	Chemox Auxiliary Self-Contained Breathing Apparatus

	Coal	Metal/ Nonmetal	
Advanced/Refresher Training*	MSHA 2101	MSHA 2201	Surface Organization
	MSHA 2102	MSHA 2202	Mine Gases
	MSHA 2103	MSHA 2203	Ventilation
	MSHA 2104	MSHA 2204	Exploration
	MSHA 2105	MSHA 2205	Fires, Firefighting, and Explosions
	MSHA 2106	MSHA 2206	Rescue of Survivors and Recovery of Bodies
	MSHA 2107	MSHA 2207	Mine Recovery
	MSHA 2108	MSHA 2208	Activity Book

***About Advanced/Refresher Training Material:**

The modules in the advanced/refresher series are devoted to the principles and procedures of rescue work. Because of the several differences between coal and metal/nonmetal mining, two separate series of modules have been provided: one set for coal use and one for metal/nonmetal mining.

An Activity Book is included in the advanced/refresher training material. It contains suggested activities to be used with the advanced/refresher modules. Some of the shorter activities can be used to break up the lecture material in a module, while others are designed to be a full training session in themselves.

Parts of the Module

Glance through several of the modules. You will notice they are set up the same way. Each module contains:

- Front matter
  - Contents
  - Course Objectives
  - Course Materials
  - Course Outline
- Text
  - Lecture Material
  - Instructor Notes
- Back matter
  - Visuals
  - Demonstration Checks (apparatus modules)
  - General Review
  - Glossary
  - Bibliography

Front Matter

Course Objectives

The Course Objectives specify exactly what the team members are supposed to learn from the module. The main objective gives you an overall training goal. The main objective is then broken down into more-detailed supportive objectives that give you step-by-step training goals.

Course Materials

Under the heading "Required" materials, you'll find a list of the materials you'll need to teach each module. Always be sure to read what's listed under "Required" materials *before* you teach a module so that you can gather these materials in advance.

Under "Suggested" materials, you'll find a list of some items which aren't necessary but do aid in preparing and presenting a more effective lecture (overhead projectors and transparencies, chalkboard, etc.).

Under "Optional Resources" is a listing of sources of additional information on the module topic. This is particularly helpful when you're planning your own "personalized" lecture, or if you'd just like to add some information about something that is not explained in the module.

Course Outline

The Course Outline shows how the module is organized, i.e., what topics you'll be discussing and in what order. If you wish you can use the outline as a guide when you prepare or deliver your own personalized lecture. You may want to use the extra space in the outline to write in page numbers of the corresponding lecture so that you can find certain sections more easily.

Text

Suggested Lecture and Instructor Notes

The text of the module is presented in a two-column or "split-page" format. On the right is the Suggested Lecture for the module and on the left are Instructor Notes which serve somewhat as "cues" to the instructor, to demonstrate something, ask questions, etc.

The lecture is written in a casual, easy-to-understand style so that you can use it and lecture from it with ease.

The instructor notes are cues to you and, as such, they have recognizable headings designed to direct you through the lecture:

- Objective
- Note
- Visual
- Reference
- Demonstration
- Demonstration Check
- Review Questions

Objective

The instructor notes preceded by the heading "Objective" simply restate the training goals found at the beginning of the module.

Note	Notes in the left-hand column are just general notes to you to help you deliver the lecture more effectively and to help you "tailor" it to your particular team.
Visual	The Visual notes cue you to show a visual from the back of the module, either as an overhead transparency, chalkboard sketch, or handout. Before you begin the lecture you should organize the visuals so that you can use them effectively during your lecture.
Reference	The Reference notes simply cite where a legal reference is or where to obtain additional information on a subject. You may want to refer to the reference in order to add some additional details to the lecture. Most of the reference notes cite 30 *CFR*, which is Title 30 of the *Code of Federal Regulations*. It's a good idea to have a copy of the latest edition on hand so that you can refer to it when necessary. You can purchase a copy from: Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402.
Demonstration	The Demonstration notes cue you to show or demonstrate something to the team. A demonstration note usually is used to help break up a rather lengthy procedure explained in the lecture, making the procedure easier for the team to understand.
Demonstration Check	A Demonstration Check note cues you to have the team members demonstrate a procedure that you've discussed in the lecture. You will be told to refer to a "Demonstration Check" form at the back of the module for a checklist you can use when evaluating each team member's performance.
Review Questions	The Review Questions should be used to reinforce what you've taught the team. *Use the questions as a tool for informal discussion rather than as a test.* This will help to break up the lecture and give the team a chance to talk.

Back Matter

Visuals

Visuals are provided at the back of the modules to go along with the lecture. What's important when presenting visuals is that all team members can see them. You can use the visuals by:

1. Making overhead transparencies of them and projecting them;

2. Drawing them on a chalkboard if the visuals are very simple line drawings or diagrams; or

3. Making copies of them and distributing them as handouts. However, distributing handouts all the time can end up disrupting the class more than helping it.

You can usually hold the class's attention best if you project the visuals or draw them on a chalkboard so that you can point out parts of the drawing or diagram as you teach.

Keep in mind that using the visuals is an optional though very useful tool for learning. It is up to you to decide which visuals to use. Use your own judgment but don't eliminate visuals just to save time. The visuals are a very important part of the learning process because they reinforce what's covered in the lecture.

Another effective way of showing the miners the visual aspect of what you're discussing is to show them a photo or even the real thing. Wherever you can, try to substitute an actual object for a visual. If you do this, the team members will pay more attention and they'll probably recognize the item more easily when they see it later.

Demonstration Checks

Some of the apparatus modules have Demonstration Checks included in them. These are used to evaluate the team during certain procedures that they must demonstrate, such as how to clean the apparatus. You will notice that each demonstration check has a checklist which you can use in evaluating each team member's performance.

General Review

The General Review questions can be used as an overall evaluation of all the material covered in the module. You should use it as a learning tool not as a test. Read the questions aloud to the team and/or distribute copies of the general review to them.

If several team members miss the same question or if there seems to be some misunderstanding about a question, make sure you go back over the corresponding part of the lecture.

Glossary

Since some of the terms you bring up in the lecture will be unfamiliar to the team, the modules include a Glossary. This glossary is provided for your convenience, as well as the teams. Be sure to look up any words you are not familiar with.

Bibliography

Each module also has a Bibliography that cites all the references used in the module. You may wish to pass along some of the references to the team members.

Master Glossary

For your reference, a Master Glossary is provided with this Instructor's Manual. It contains a complete list of terms applicable to mine rescue and apparatus.

Glossary

air lock An area in the mine closed at both ends by doors or by stoppings (bulkheads) with flaps or doors in them. Used to prevent mixing of different atmospheres while allowing miners to enter and exit.

air shaft Shaft used exclusively for conducting air.

air split The division of an air current into two or more parts.

airway Any passage through which air is flowing.

anemometer Instrument used for measuring medium-velocity (120-2,000 ft./min.) and high-velocity (2,000-10,000 ft./min.) air currents in the mine.

antidim A solution used to keep moisture and dirt from adhering to the apparatus's facepiece lens.

approval label Label on apparatus showing approval by the government and any specifications for how the apparatus must be used to meet that approval.

area (of an airway) Average width multiplied by average height of an airway, expressed in square feet.

ASCBA Auxiliary self-contained breathing apparatus.

asphyxiate To suffocate or choke.

atmosphere (measure) A unit of pressure equal to approximately 14.7 PSI.

atmospheric pressure Force exerted by air. Atmospheric pressure is measured on a barometer.

auxiliary fan A small, portable fan used to supplement the ventilation of an individual working place.

auxiliary self-contained breathing apparatus Apparatus that provide 30 to 60 minutes' service time.

auxiliary ventilation Portion of main ventilating current directed to face of dead-end entry by means of an auxiliary fan and tubing.

backup team The rescue team stationed at the fresh air base as a "backup" for the working team beyond (inby) the fresh air base.

baffle A device used to deflect, check, or regulate the flow of air.

bail A hinged bar on the bottom of the Chemox apparatus that holds the canister in place.

barricade Enclosed part of mine to prevent inflow of noxious gases from a mine fire or an explosion. This may be done by doors or by building one or more airtight walls using any available materials, such as rock, wood, brattice cloth, mud, clothing, etc., so as to enclose a maximum quantity of good air.

bench area An area where apparatus is cleaned, tested, and prepared for use.

benchman A person who has responsibility for testing and maintaining the team's apparatus and equipment. A benchman may or may not be a mine rescue team member.

blower A gas feeder under high pressure which causes the gas to issue at considerable velocity.

box check A stopping with an opening in it to allow a conveyor to pass through, used to prevent intake or return air from flowing across the conveyor.

breathing bag Part of the apparatus that contains oxygen-enriched air as a reservoir for breathing.

breathing hoses Hoses that connect the apparatus to the facepiece, allowing air to travel to and from the facepiece.

briefing Session held before a team goes underground to inform team members of conditions underground and give them their work assignment.

bulkhead A wall or partition constructed of incombustible material across a passageway to direct the ventilating air in its proper course.

Cardoxide The soda lime mixture used in the McCaa's regenerator to absorb carbon dioxide.

casing Piping used to support sides of a borehole and to prevent entry of loose rock, gas, or liquid.

chain-of-command Order of authority and division of responsibilities among personnel.

check curtain or run-through check Brattice cloth, canvas, or plastic curtain used to deflect or direct air into a working place. Constructed in a manner to allow the passage of miners and machinery.

Class A fires Fires that involve ordinary combustible materials such as wood, coal, plastics, paper and cloth. They are best extinguished by cooling with water or by blanketing with certain dry chemicals.

Class B fires Fires that involve flammable or combustible liquids such as gasoline, diesel fuel, kerosene, and grease. They are best extinguished by excluding air or by special chemicals that affect the burning reactions.

Class C fires Fires that involve electricity. They are best extinguished by nonconducting agents such as carbon dioxide and certain dry chemicals.

Class D fires Fires that involve combustible metals such as magnesium, titanium, zirconium, sodium, and potassium. Special techniques and extinguishers have been developed to put out these fires.

closed circuit breathing apparatus An apparatus that recirculates exhaled air and makes it safe for rebreathing by removing the carbon dioxide and adding fresh oxygen.

combustible Capable of burning; flammable.

command center Headquarters for the rescue and recovery operation.

compressed oxygen Gaseous oxygen that is contained under pressure.

condensation A reduction to a denser form, for instance gas to a liquid.

contaminant Something which fouls or impurifies.

corrode To eat away gradually.

crosscut *For single-level, room-and-pillar mines:* A passageway driven at right angles between an entry and its parallel aircourse (or aircourses) for ventilation purposes. *For multi-level mines:* A tunnel driven perpendicular to the main vein system of the mine.

"D" ring Metal "D" shaped ring.

damps Descriptive names given by miners to identify mixtures of gases.

debriefing Session held when a team returns to the surface after completing an assignment to review what they saw and did.

demand type of apparatus An apparatus that supplies air to the wearer on demand, during inhalation only, and may have negative pressure within the facepiece.

Dewar flask Container used to carry liquid oxygen from the storage tank to the filling site for filling the Aerorlox apparatus.

diffuse To scatter, spread out, or blend.

direct firefighting Method of firefighting where dry chemical extinguishers, water, foam, or rock dust (in coal mines) are put directly onto the fire to extinguish it.

direct ventilation Reventilation of the entire sealed area at once.

disperse To scatter or get rid of; to dispel.

downcast Intake ventilation shaft.

drift A mine opening, usually not intersecting the surface, that follows the direction of the vein (often within the vein).

entry An underground passage used for haulage, ventilation, or as a manway.

evaporate See *vaporize*.

exhaust The air course along which the ventilated air of the mine is returned or conducted to the surface.

exhaust air The air that has passed through all the working areas and is on the way out of the mine.

explosive range The range of concentrations within which a gas will explode if ignited (expressed in percentages).

extricate To disentangle.

face The principal operating place in a mine; the working place where fresh ore or coal is exposed and extracted. A mine may have many operating faces.

facepiece Part of the apparatus that fits over the face and forms an airtight seal against the outside air.

feeder Small cracks in rock strata through which methane or other gas escapes.

fire triangle Triangle used to illustrate the three elements necessary for fire to occur: fuel, oxygen, and heat.

flammable Burnable.

Flordol Disinfectant used to clean the Aerorlox.

flowmeter A device used to measure air or oxygen flow.

fractional distillation A process of evaporation and recondensation to separate the various components of a liquid mixture, for example, to separate liquid oxygen from liquid air.

fresh air base Base of operations from which the rescue and recovery teams can advance into irrespirable atmospheres.

getting under oxygen A phrase that refers to the process of putting on the apparatus, turning on the oxygen, and making sure the apparatus is functioning properly.

glycerine A liquid product which can be used as a lubricant and softener. Glycerine can be used for treating frostbite.

gob Waste materials in the mine.

head coal The top portion of a coal seam left unmined, either permanently or temporarily to be mined afterwards.

heading An entry.

high expansion foam Foam used in firefighting that is light and resilient and can travel long distances without breaking down. Made by mixing water, air, and a high expansion foam concentrate or detergent in a foam generator.

hydrogen pops Small explosions of hydrogen gas.

hydrostatic test A test performed on oxygen cylinders every 5 years to check the cylinder's elasticity. (Water is pumped into the cylinder to a pressure greater than the cylinder's pressure service rating to measure how much the cylinder expands.)

hysteria Unmanageable fear or emotional excess.

ignite To set on fire.

inby Toward the working face from a point; the opposite of outby.

inches water gauge One inch water gauge equals the pressure of 5.2 pounds per square foot.

indirect firefighting Method of firefighting where the fire area is sealed or filled with foam, water, or sandfill (in metal/nonmetal mines) to exclude oxygen from the fire and, in the cases of water and foam, to cool the fire.

inert gas A gas that doesn't react chemically with other gases: an "inactive" gas.

intake The passage through which fresh air is drawn or forced into a mine or to a section of the mine.

inundation The state of being flooded.

irrespirable Unfit for breathing.

lanyard The cord on the Chemox's Quick Start canister that you pull to fire the starting candle.

lifeline Ropeline or cable from communications system that links the team to the fresh air base. It may be used as a manual communications system to the fresh air base (30 CFR, 49.6(a)(8)).

line brattice or brattice cloth Fire-resistant fabric or plastic partition used in a mine passage to direct the air into the working place. Also termed "line canvas."

linkline Line that links team members together. Used in smoke, it is usually a rope about five feet long with rings for each team member to hook onto.

liquid oxygen Oxygen in the liquid state, which is oxygen at −297° F (−183° C) or lower in temperature.

liter Metric unit of measure that is almost equivalent to one quart (1 quart = 0.95 liter).

low expansion foam Foam used in firefighting that is wet and heavy and therefore must be forced directly onto the fire. Made by mixing a low expansion foam concentrate or detergent with water in a foam nozzle attached to a fire hose.

LPM Liters per minute.

lung demand assembly diaphragm A dividing membrane or partition in the Draeger apparatus which moves in and out depending on the pressure in the breathing bag.

Magnehelic Gauge An instrument used to measure air pressure (calibrated in inches of water).

main entry The main haulage road.

main fan A mechanical ventilator installed at the surface which operates by either exhausing or blowing (pushing) to induce airflow through the mine.

man door Door installed in a permanent stopping (bulkhead) to allow persons to travel from one entry to another.

manometer A device, calibrated in inches water gauge, used to measure pressure.

methane outburst Sudden emission of methane from ore or coal seam or surrounding rock.

millibar A unit of atmospheric pressure equal to 1/1000 bar.

millimeters water (mm H_2O) The movement of water (caused by a negative or positive pressure) measured on a scale calibrated in millimeters.

mine atmosphere The air in an underground mine.

mine door A large, hinged door used to close off a mine entry. Doors are usually installed in pairs to form an air lock.

Model 1.05, Model 1.07 Two slightly different models of the Aerorlox. The 1.07 is the newer model.

MSHA Mine Safety and Health Administration

negative pressure Pressure less than normal atmospheric pressure, creating a "sucking in" force.

NIOSH National Institute for Occupational Safety and Health.

notification plan Plan for notifying necessary personnel when there is an emergency at the mine.

noxious Harmful to the health.

one-way valve A valve which operates in one direction only--either outward or inward.

open circuit breathing apparatus An apparatus that expels all the wearer's exhaled air (thus the carbon dioxide), and provides fresh air to breathe.

orifice A hole.

outby Toward the shaft or entrance from a given point; the opposite of inby.

overcast Enclosed airway built at an intersection of mine passages that permits one air current to pass over another air current without mixing.

oxidize To cause to combine with oxygen.

peripheral vision The outer part of the field of vision, especially the sides.

poison Substance which destroys life or health.

positive pressure Pressure greater than normal atmospheric pressure, creating a "pushing out" force.

potassium superoxide A chemical in the Chemox canister which produces oxygen upon contact with moisture in your breath.

PPM Parts per million.

preflush Passing oxygen quickly through the Draeger apparatus before actual use to purge any nitrogen and to inflate the breathing bag.

pressure demand type of apparatus An apparatus that provides a continual small supply of air to the facepiece, as well as additional air on demand when the wearer needs it during inhalation. This type of apparatus has positive pressure within the facepiece.

pressure relief valve A device designed to release excess pressure that builds up in the apparatus.

pressure service rating The maximum pressure to which an oxygen cylinder can be filled. (Usually measured in PSI and stamped on the neck of the cylinder).

primary self-contained breathing apparatus Apparatus that has at least a 2-hour service time.

progress reporting Information the team relays to the fresh air base as it proceeds.

progressive ventilation (or stage ventilation) Reventilation of a sealed area in successive blocks by means of air locks.

Protosorb The soda lime mixture approved for use in the Aerorlox absorbent canister (8/12 mesh) to absorb carbon dioxide.

PSI Pounds per square inch.

putrefaction The decomposition of organic matter by bacteria, fungi, and oxidation, resulting in the formation of foul-smelling products.

quadrant Any of four quarters into which something is divided.

reagent A substance that causes chemical activity.

refuge chamber An airtight, fire-resistant room in a mine, used as a method of refuge in emergencies by miners unable to reach the surface.

regenerative canister A part of self-contained breathing apparatus which functions to absorb carbon dioxide from the exhaled breath.

regulator An adjustable door or opening in a stopping (bulkhead) or a partially open mine door (in metal/nonmetal mines), used to control and adjust the quantity of airflow in the mine in order to ensure proper distribution.

return The air course along which the ventilated air of the mine is returned or conducted to the surface.

return air The air that has passed through the working areas of the mine and is on its way out of the mine.

rigor mortis The progressive stiffening of the muscles that occurs several hours after death as a result of the coagulation of the muscle protein.

rock bump Sudden, violent expulsion of coal from one or more pillars, accompanied by loud reports and earth tremors.

rock burst An explosive breaking of coal or rock in a mine due to pressure.

rotation schedule Schedule that establishes a clear order of team usage during a rescue and recovery operation.

sandfill Crushed waste rock that is pumped as a slurry and when it dries has the consistency of sand.

SCBA Self-contained breathing apparatus.

Schedule 13 Bureau of Mines' former set of standards for testing and approving SCBA.

seal A stopping built of greater thickness and more substantial construction used to isolate abandoned areas of the mine from the active workings or to isolate a fire.

self-contained breathing apparatus A unit that is worn to supply the wearer with safe air to breathe. An SCBA has its own supply of oxygen or air and has a means of removing carbon dioxide from the wearer's exhaled air.

serial number plate A metal plate on the side of the outer container of the Aerorlox apparatus that lists the serial number and weight of the outer container stripped of all the removable parts.

service time The length of time an apparatus is approved to be used per wearing (for example ½, 2, or 4 hours).

shelf life The length of time that a product can be stored before it begins to deteriorate.

smoke Tiny particles of solid and liquid matter suspended in air.

smoke tube Instrument used for determining direction and velocity of slow-moving air (below 120 feet per minute).

soda lime A chemical, which resembles vermiculite, used to absorb or "soak up" carbon dioxide from exhaled air that passes through it.

solubility Ability to dissolve in water.

speaking diaphragm A thin, flexible disc, usually a part of the facepiece, that vibrates (much like a microphone) to allow transmission of one's voice to the outside while wearing the facepiece.

specific gravity The weight of a gas compared to an equal volume of normal air under the same temperature and pressure.

standby team Team scheduled to be on the surface in ready reserve when rescue teams are working underground.

stopping A permanent or temporary wall or partition constructed of incombustible material across a passageway to direct the ventilating air in its proper course and to separate intake air from return air.

sulfur A nonmetallic element which exists either free or in combination with other elements. It often occurs as pyritic sulfur, commonly known as "fool's gold."

team check Check of team members and their apparatus periodically while working under oxygen. Team checks vary according to the type of apparatus being worn.

30 CFR Title 30 of the *Code of Federal Regulations.*

TLV Threshold Limit Value. Used to denote the average concentrations of gases to which workers can (under Federal regulations) be exposed over an 8-hour period.

toxic Poisonous.

trauma, physical Injury to living tissue.

trauma, psychological Disordered psychic or behavioral state resulting from mental or emotional stress or physical injury.

traverse To move across. A traverse measure of air velocity is one that is taken by walking across an airway.

triage System of assigning priorities of medical treatment to injured people.

tying in Systematic exploration of all crosscuts and adjacent entries in a single-level, room-and-pillar mine so that the team is never forward of (inby) an unexplored area.

undercast An enclosed airway built at an intersection of mine passages that permits one air current to pass under another air current without mixing.

upcast Exhaust ventilation shaft.

vacuum bottle Container used to collect gas samples for chemical analysis.

vaporize, evaporate To change from a liquid to a vapor or gas. In the Aerorlox, liquid oxygen vaporizes or evaporates to gaseous oxygen.

velocity Rate of airflow in linear feet per minute.

volatile coal Coal that gives off volatile matter (gases and vapors) when heated. Lower rank coal, such as lignite, gives off more volatile matter than higher rank coal, such as anthracite.

water lance A pipe about 10 feet long with holes along the length of it with a fitting to attach to a hose line.

water gauge A means of measuring air pressure expressed in terms related to the height of a column of water. Water gauge is expressed in units known as "inches of water."

WL (working level) Measure of the potential alpha particle energy of radon daughters in a mine atmosphere.

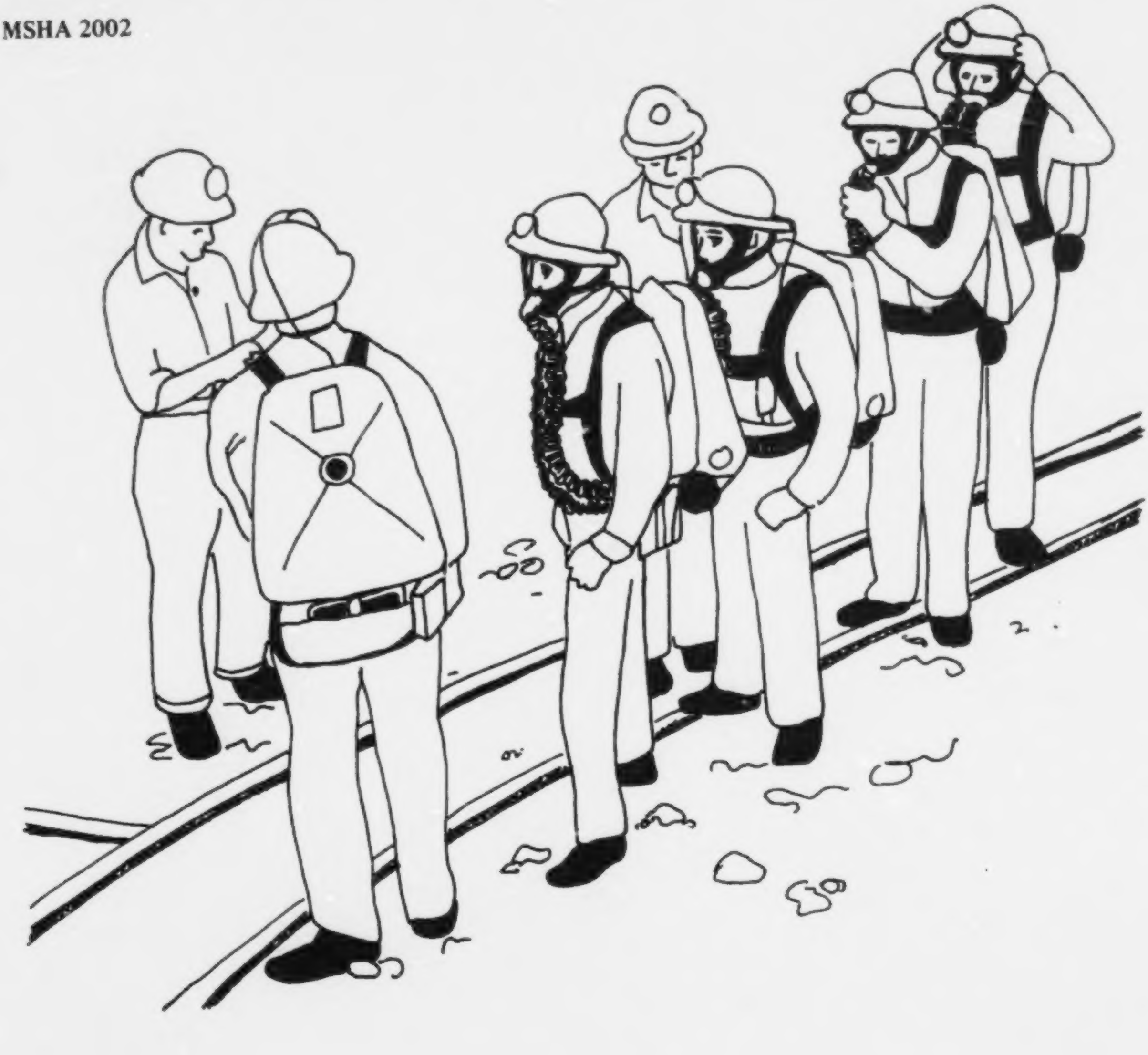
WLM (working level month) Special unit used to measure worker's exposure to airborne radiation.

Introduction to Mine Rescue

Training Module–Initial Mine Rescue

U.S. Department of Labor
Mine Safety and Health Administration
Education and Training Directorate
November 1981

MSHA 2002



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Training Module–Initial Mine Rescue

U.S. Department of Labor
Raymond J. Donovan, Secretary

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November 1981

MSHA 2002

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Course Objectives

Main objective

The mine rescue team member will identify the history, function, and duties of mine rescue, and the qualifications for team membership.

Supportive objectives

The team members will:

1. Identify significant events in the history and development of mine rescue.
2. Identify the laws and regulations governing [illegible] teams.
3. Define mine rescue and list its objectives.
4. Define the mine rescue team concept and identify the tasks and procedures associated with mine rescue work.
5. Identify the mine rescue team composition and the roles of team members and ancillary personnel.
6. Identify the qualifications necessary for team membership.

Course Materials

Required:

Handouts and visuals from the back of this module.

Pencil and paper for each team member

Suggested:

Overhead projector

Equipment for making copies and/or transparencies

Chalkboard

Optional Resources:

Title 30, Code of Federal Regulations, Part 49: Mine Rescue Teams

Films available from MSHA:

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Instructor Notes

Note: What follows are two factual accounts of actual mine rescues. They are provided only as examples and can be omitted at your option. They're intended to spark the team's interest and to give them some indication as to what they'll be up against as members of the team. If you have firsthand knowledge of another rescue, if you participated in one, or you know the details of another rescue that you feel would "work" better here, feel free to substitute it for one or both of the accounts provided. Remember that the objective is to give the team a "taste" of the type of work they may be doing.

Also, please keep in mind that this module is, as titled, only an "Introduction" to mine rescue. More detailed information on mine rescue will be presented in the other modules in this training series.

Suggested Lecture

INTRODUCTION

It was a tragic date that would live forever in the history of Eccles, West Virginia—March 8, 1926. Disaster struck at about 7 in the evening, just after the night crew had gone on duty. The last group of miners had barely reached the bottom of the shaft when an explosion rocked the Eccles Nos. 5 and 6 mines.

The force of the blast propelled a miner's boot out of the No. 5 shaft like it had been shot from a cannon. Then came flames. Smoke, dust, and debris billowed from both portals.

Those on the surface went into action immediately, notifying state and local officials. Police were at the site within minutes, attempting to control the crowd already gathering outside the mine. Local rescue teams responded promptly to the call for help.

Meanwhile, afterdamp—the deadly combination of gases that often follows such an explosion—made its way from the No. 5 to the No. 6 mine, killing one miner. A quick-thinking motorman, however, short-circuited the path of the afterdamp by opening a mine door, and 29 miners in the No. 6 mine escaped.

But things didn't look so good for the 30 miners still trapped inside the No. 5 mine. It was there that the explosion had originated.

Working in 8-hour shifts, the rescue crews slowly made their way toward the bottom of the shaft. On their way down, the crews recovered the first 7 bodies amid the concrete and rubble heaped high in the shaft. There were 7 of them—all horribly burned. There seemed little hope that anyone could have survived. But 23 miners remained unaccounted for, so the rescue operation continued.

Upon their arrival at the bottom of the shaft, the crews faced a grim picture of near total destruction. The force of the blast had upended mine cars and tossed them along the haulageway. Timbers were scattered everywhere, and slate had fallen on battered equipment. In addition, water lines had broken, flooding the sump beneath the shaft.

The crews continued to work their way on into the mine in search of survivors. Progress was slow. Besides clearing away debris that blocked their path, the crews had to build stoppings to dispel afterdamp and re-establish ventilation. As they moved forward, the damage became less severe, indicating that the explosion had blown to the outside.

Twenty-six hours after the initial blast, the crews came upon a crudely lettered sign: "Come to second right," it read. Spurred by hope, the crew proceeded in that direction only to find, moments later, the bodies of two miners–evidently felled by afterdamp. Handkerchiefs they'd used in a futile attempt to ward off the gases were still tied over their faces.

The crew continued on toward the second right. On the way they found another sign: "Third room," it said. And then they found another body–a third miner felled by afterdamp.

Meanwhile, news of the mounting tragedy below had found its way to the surface. The crowd's mood of desperate optimism turned to agonizing despair. It was only a matter of time. That day, a local newspaper headline echoed the sentiment: "All had been given up for lost," it read.

But rescue crews continued their round-the-clock search for survivors. By 8 p.m. the day after the explosion, they'd reached the object of their search: The third room, second right.

It was here that the signs had led them. And here that they found what they'd hoped to–a barricade–hastily but skillfully erected. It was constructed of brattice cloth folded over four times and reinforced with stones, broken timbers, and mud. And behind it were 10 men–all alive.

Quickly, the crews broke through the walls that had sealed the miners from the deadly afterdamp. The rescuers hurried them to the shaft, where they were hoisted to the surface amid glad cries and tears of joy.

Bolstered as they were by the rescue of the 10 barricaded men, the rescue teams could not stop to join in the celebration on the surface. Their work underground was hardly finished. They continued to search for survivors and to recover the mine.

The last 3 bodies were found, days later, in the wreckage at the bottom of the shaft.

In all, 19 died in the Eccles disaster. Ten were rescued.

* * *

On August 14, 1963, a supporting pillar collapsed, trapping 3 miners 300 feet underground in a slope mine in Oneida, Pennsylvania.

Rescue teams made several attempts to reach the men using conventional methods, but all of them failed. Three days later, the rescuers abandoned standard methods in favor of a more innovative approach. They brought in a 6-inch survival drill.

The survival drill was a relatively new concept in mine rescue. It had been tried in several similar situations, but there was no record that it had ever met with success. This time it had to work. The lives of the trapped miners depended on it.

The idea was to drill a small hole into the place where the miners were trapped, establish communications, and lower supplies, and then proceed to drill a larger hole through which the miners could be hoisted to the surface. The whole thing sounded simple enough but it wasn't. One of the most difficult tasks was just figuring out exactly where to drill.

Using only some rough approximations as to where the miners might be located, the rescuers began to drill. Their first try was successful. Miraculously, they managed to guide the drill directly into the pocket where two of the miners were trapped. Soon, they'd established communications with the men, and lowered food, water, and other necessities to them.

The hardest work was yet to come. Another hole was drilled, and then reamed so that it would be big enough to pull the men up through it.

By August 27th, the hole was large enough. The rescuers lowered coveralls fitted with parachute harnesses to the men, along with a big bucket of grease. Then one-by-one they were hoisted from their prison, wearing the special coveralls and covered from head-to-toe with the grease which was designed to ease their passage to the surface.

Fourteen days had passed since the men had first been trapped underground. But thanks to the persistance of their rescuers, they were safe–and alive.

* * *

Over 35 years separate the Eccles and Oneida incidents. Much change came between them, and many technological advances. Yet the stories share many common characteristics. And they are far from being isolated incidents.

Throughout history, these accounts and others like them have made mine rescue synonymous with courage, and with heroism of near-legendary proportions.

These stories illustrate the determination and tenacity that are the hallmarks of mine rescue. They are stories of disaster, of hope, and finally, of rescue in the face of overwhelming odds.

On a smaller scale, they are the stories of a select few who would risk their own lives to save the lives of others. And this is a very important part of what mine rescue is all about.

Reference: For more information on these and other mine rescues, see the Bureau of Mine's Bulletin No. 586: *Historical Summary of Coal Mine Explosions in the U.S., 1910-1958.*

HISTORY OF MINE RESCUE

Objective 1: The team members will identify significant events in the history and development of mine rescue.

Early Disasters and Rescue Efforts

In this country, the first recorded mine disaster took place near Richmond, Virginia in 1839. Since that time, records show that thousands of miners in this country have lost their lives in the mines.

In one form or another, mine rescue has been around as long as underground mining. But it wasn't always the well-organized "team" effort that we know today.

In its earliest days, mine rescue was a haphazard effort at best. Rescue "parties" were little more than groups of miners and other volunteers who happened to be at the mine site at the time of the disaster. As heroic and well-intentioned as their efforts may have been, these people were ill-equipped for the work at hand. They had no mine rescue training, no equipment, and no reliable breathing gear. The odds were against them. All too often, their names were added to the already large list of those who died in the disasters.

In the United States, the turn of the century was a particularly hazardous time to be a miner, as is reflected by the numbers of those who died in disasters at that time.

The 1907 Monongah disaster in West Virginia, for example, claimed 362 lives. (This is still recognized as the largest single mining disaster in the United States.) Also in 1907, 239 miners lost their lives in Pennsylvania's Darr disaster. In 1908, the Marianna disaster, in Pennsylvania, claimed 154 lives. And 259 died in the Illinois Cherry disaster of 1909.

Origins of Mine Rescue

Besides being a time marked by great disasters, the early 1900's also ushered in some important events which marked the origins of mine rescue as we know it today.

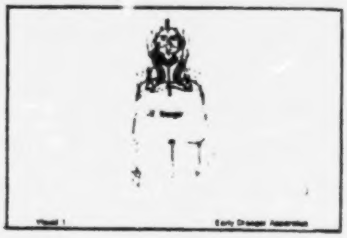
First SCBA

Note: A more complete history of apparatus development will be presented later on in the *Introduction to Self-Contained Breathing Apparatus* training module (MSHA 2003).

In 1907, for example, a self-contained breathing apparatus (a Draeger) was first introduced in this country.

Visual: Refer to "Visual 1" for a picture of the early Draeger breathing apparatus as you discuss this.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Note: If they aren't familiar with the term, tell the team that "SCBA" stands for "self-contained breathing apparatus." Point out that the SCBA is a device that supplies its wearer with fresh oxygen and removes carbon dioxide from exhaled air. The unit functions completely independent of the air around it, so it provides breathing protection when surrounding air is unfit to breathe. "SCBA" will be used interchangeably with "self-contained breathing apparatus" in this and following modules.

The introduction of self-contained breathing apparatus (SCBA's) meant that, for the first time, those entering mines filled with irrespirable air could carry their own breathing air along with them. Of course, the amount of time the rescuers could stay underground was naturally limited by the amount of oxygen their gear provided, but it was a start.

The new SCBA's were first used to fight a mine fire in Butte, Montana, in 1907, and they went on to figure in the success of many future mine rescue efforts.

Even though rescuers now had reliable breathing protection, their efforts were still hampered by lack of organization, training, and equipment.

In 1908, an early apparatus "crew" of five men entered a mine after a disaster in Star Junction, Pennsylvania. At first glance, this attempt appears to be a forerunner of today's "team" rescues, but the effort was not a highly organized one, and the crew was not trained specifically for mine rescue work. At this point, the idea of using an organized, specially trained and equipped group or "team" of individuals was an idea still in its formative stages.

Helmet Crews

In 1910, however, the U.S. Bureau of Mines was formed, and with it came the organization, training, and "team" element that mine rescue so badly needed.

Visual: Refer to "Visual 2" for a picture of an early U.S.B.M. helmet crew.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Visual 2
Early Helmet Crew

The Bureau established a network of specially outfitted railroad cars and placed them at strategic locations throughout the mining areas of the United States. Each car served as a base of operations for a group of individuals trained and equipped specifically for mine rescue work.

Because their breathing gear's full head covering resembled a deep sea diver's helmet, the groups became known as "helmet crews." The crews were trained to respond quickly and professionally to disasters in their own districts, much as modern teams do.

The new helmet crews were called on to lend a hand at several major disasters, and they were responsible for saving the lives of scores of trapped miners. Although the crew's access to breathing gear and other equipment was a great help to them, their success could be attributed to more than that.

For the first time, the rescuers had the training and organization they needed to turn an uncoordinated, often even chaotic, rescue attempt into a well-coordinated, efficient group effort. The birth of the early helmet crews clearly marked the beginning of modern mine rescue teams.

The 1940's

In the 1940's, World War II spurred increasing demand for mined products, so more miners were put to work. At the same time, the mines were becoming more highly mechanized. These factors combined to produce more hazards, and the result was more chance for disaster.

In terms of sheer numbers, the disaster statistics of the 40's came nowhere near matching those of earlier years, but they were nonetheless sobering. In 1940, for example, the Bartley No. 1 coal mine in West Virginia claimed 91 lives. In 1942, 56 died in the Christopher No. 3 coal mine disaster also in West Virginia. And a disaster at the Centralia No. 5 coal mine in Illinois claimed 111 lives in 1947.

These tragedies pointed to the need for preventing disasters by reducing the hazards that led to them. There were big changes afoot. Even though mining was a hazardous occupation, there were ways to make it safer.

On the state and Federal levels, this meant establishing and enforcing laws aimed at making the mines safer places in which to work. Mining companies also joined in the effort to reduce mining hazards by developing safety programs and improving conditions within the mines. To some extent, the changes worked. The number of disasters decreased, as did the number of those who died in them.

Today, great emphasis is still placed on establishing and enforcing mine health and safety regulations. This continues to significantly reduce mining hazards. Modern technological advances and increased mechanization have also made it possible for fewer miners to remove ever-increasing amounts of materials from beneath the earth's surface. This reduction in the number of manhours required to do work has also reduced the chance for disaster.

Recent Disasters

Although these changes have helped reduce the incidence of disaster in the mines, they have not totally eliminated the problem. Disaster still haunts the mining industry. This becomes all too evident as you call to mind some of the disasters that have taken place in recent years.

Witness, for example, the tragedy that took place at the Sunshine Mine in Kellogg, Idaho when 91 miners died from fire and carbon monoxide poisoning in 1972. In 1968, 78 miners died in an explosion at the Farmington No. 9 mine in West Virginia. In that same year, 26 miners died in a disaster inside the Belle Isle Salt Mine in Louisiana. In 1980, an explosion claimed 5 lives at the Ferrel No. 17 coal mine in southern West Virginia. And, in 1981, a methane explosion in the Dutch Creek No. 1 coal mine near Redstone, Colorado killed 15 miners.

The Mine Rescue Tradition

Through the ages, miners have traveled underground secure in the knowledge that if disaster should strike, other miners would make every possible attempt to rescue them. They knew the rescue effort would begin quickly, and that the rescuers would keep on trying until they'd searched every corner of the mine. History demonstrates that this type of rescue has always been the rule rather than the exception.

Today's miners are no different in this respect. They too journey underground knowing that the work they do is hazardous, and that despite everything that's been done to prevent it, disaster still occurs.

And, like their predecessors, today's miners carry with them the knowledge that if disaster strikes and they become trapped in the mine, others will try to rescue them. And they know the rescuers won't give up until they've exhausted all hope of ever finding them alive. This is the mine rescue tradition.

MINE RESCUE TODAY

The mine rescue teams today's miners depend on are a far cry from their earlier counterparts. Rescues are no longer disorganized, haphazard affairs taken on by whoever happens to be in the area at the time of the disaster. Today's rescues are highly organized efforts carried out by a group of individuals working together as a team.

Recent developments in mine rescue emphasize two very important areas: training the teams, and improving the equipment they use.

For example, the new Federal requirements for mine rescue, which we'll talk about later on, set minimum standards for setting up, training, and equipping mine rescue teams. The law stresses that each member of the team must have practical training, and it sets guidelines for equipment maintenance and inspection. This helps to ensure that well-trained, properly equipped teams will be ready to work quickly and efficiently during an actual emergency.

Reference: The reference for this section is 30 *CFR*, Section 49.2.

Today's teams also have modern technology to thank for the increasingly sophisticated array of equipment they use to supplement their efforts. Early apparatus crews could count on their SCBA's to provide only one or two hours of breathing protection. Today's teams have much longer duration apparatus, plus many other devices that their predecessors, armed primarily with shovels, picks, and hatchets, probably never even dreamed of.

Today's teams, for example, use modern gas detection and communication equipment. They also have at their command the latest techniques and devices for sealing mines and fighting fires.

The computer age has also provided mine rescue with seismic locators, geophones, and other devices used to pinpoint trapped miners. These are all a part of MSHA's Mine Emergency Operations (MEO), along with two National Mine Rescue Teams–one for coal mines and one for metal/nonmetal mines.

MSHA MEO also possesses the capability to drill boreholes down from the surface to reach miners who, in an earlier time would have been given up for dead. Once a borehole is drilled with what's known as a "survival drill," rescuers can lower cameras, lights, and microphones into the mine to help locate the miners, determine their situation, and lend support and assistance while an escape route is drilled. Once that is complete, the trapped miners can be safely hauled to the surface in specially designed "escape capsules."

Rescue teams in some areas (such as Pennsylvania and Utah) also have access to another advanced form of supplementary mine rescue equipment–the mobile mine rescue van.

Designed for use during prolonged rescue efforts, these vans are equipped to serve as a base of operations for one or more teams throughout a rescue. The vans are outfitted with standard mine rescue gear such as breathing apparatus, recharging facilities, hand tools, and first aid supplies.

Some of the vehicles can boast the additional distinction of being virtual "moving laboratories," equipped with computers and other devices sophisticated enough to perform delicate tests like on-site gas analysis–a time-consuming task previously performed only in distant laboratories.

Despite all the technological advances that have been made in mine rescue over the years, none have lessened the need for trained mine rescue teams. Nothing can replace the response of a well-trained team. Instead, all of the methods, techniques, and devices we've talked about simply serve to make today's mine rescue team's job safer and far more effective than ever before.

MINE RESCUE AND THE LAW

Before Part 49

Objective 2: The team members will identify the laws and regulations governing mine rescue teams.

Until recently, all underground mines were not required to have access to mine rescue teams. Many of the teams now in existence were set up voluntarily–often in reaction to the tragedy of a major disaster. Other mines often followed suit, realizing that even though they had not experienced a disaster, it paid to be ready for one.

Many state departments of mines set up teams of their own so that they too would be ready to lend a hand if a disaster should occur. MSHA also trained and outfitted its own teams to ensure they would be ready to respond at a moment's notice to a disaster anywhere in the United States.

Part 49

It wasn't until recently, however, that the U.S. Congress passed laws making it mandatory for every mine in the country to have access to mine rescue teams. These regulations are contained in Part 49 of Title 30 of the Code of Federal Regulations (30 CFR).

Note: The regulations in 30 *CFR*, Part 49 fulfill requirements set forth in the Federal Mine Safety and Health Act of 1977, sections 101 and 115 (e).

"Part 49," as we'll refer to it here, will have far-reaching consequences for mine rescue. For one thing, by making it mandatory for every mine to have rescue teams available, it will greatly increase the number of teams throughout the country.

Part 49 also specifies how many members each team should have, what equipment they should have on hand, and how the equipment is to be stored and maintained. The law also contains requirements for the notification plan to be used during an emergency.

Part 49 also specifies what physical standards and other qualifications you must meet to be eligible for team membership, and it sets some minimum standards for the amount and type of training you receive.

Since Part 49 is such an integral part of modern mine rescue, let's take a look at some of its major points. Keep in mind that as members of a mine rescue team, many of the regulations we'll talk about will directly affect you.

Availability

According to Part 49, every mine must have at least two mine rescue teams available for rescue and recovery work at all times. Each team must consist of five members and one alternate.

Reference: The legal reference for the preceding paragraph is 30 *CFR*, section 49.2(a) and (b)

Note: There are some exceptions to this rule. The law also provides for alternative mine rescue setups in some situations (e.g. for small or remote mines, or those with special mining conditions). If your mine fits one of these categories, or if other unique circumstances qualify it for an alternative mine rescue plan, you may wish to refer to *30 CFR*, sections 49.3 and 49.4 for further information on alternative compliance.

Training

According to law, if you're a new mine rescue team member, you must have at least 20 hours of instruction on how to use, care for, and maintain the breathing apparatus your team uses.

Note: This requirement doesn't apply to those already on teams when the law goes into effect. You may wish to mention this if it applies to your team.

Once you've completed this initial training, the law requires that you receive at least 40 hours of additional training every year as long as you're on the team. This is known as "advanced/refresher" training. As part of this advanced/refresher training, the law requires that you have at least one underground session every six months. The law also specifies that you practice under oxygen for at least two hours every two months during your refresher training.

Reference: The reference for the preceding information on training is 30 *CFR*, section 49.8(a) and (b).

Note: Keep in mind that these are the minimum standards required by law. Many teams will do more than what's required. Point this out to your team, especially if their training exceeds the minimum requirements.

Besides "reviewing" your basic apparatus skills, your 40-hour advanced/refresher course will introduce you to advanced mine rescue skills, keep you abreast of changes, and give you a chance to do some practical, problem-solving work.

Eligibility

As we mentioned earlier, Part 49 also designates what standards make you eligible for team membership. For instance, the law says that in order to be on a team you must have worked in an underground mine for at least one year during the past five. You also qualify if you're employed on the surface but regularly work underground.

Note: Those already on a mine rescue team at the time the law goes into effect do not need to meet the experience requirements. Mention this if it applies to members of your team.

Reference: The reference for this is 30 *CFR*, section 49.2(c).

The law also specifies what physical standards you must meet in order to become a team member. We'll talk about the "physical qualifications" aspect of the law later on in the lecture.

Reference: The reference for this is 30 *CFR*, section 49.7.

Mine Rescue Station and Equipment

Another part of the law requires that a mine rescue station be established "to provide a centralized storage location for mine rescue equipment." The rescue station is where you'll store and maintain equipment so it will be ready to use immediately during an emergency.

Reference: The reference for this is 30 *CFR*, section 49.5.

The law also specifies what equipment must be available at the mine rescue station. For instance, according to law, the station must be outfitted with at least twelve self-contained breathing apparatus, equipment necessary to test them, and enough carbon dioxide absorbent chemicals and oxygen to supply six hours of breathing protection for each team member.

Note: If the team uses compressed oxygen breathing apparatus, tell them that the law also requires that the station be equipped with one extra charged oxygen cylinder for every 6 SCBA's and an oxygen pump or cascade system to recharge the cylinders.

The law also requires that the rescue station be provided with at least twelve permissible cap lamps, facilities to recharge them, two gas detectors for each type of gas found in the mine, and two oxygen indicators or flame safety lamps.

According to law, there must also be an approved mine rescue communications system at the rescue station, and you must be provided with enough spare parts and other tools to maintain both the communications system and the breathing apparatus.

Note: Keep in mind that this is the minimum amount of equipment required by law. Most teams will have more equipment than this. Point this out to the team, and mention any other equipment that is available at the mine rescue station.

Reference: The reference for the preceding information about equipment is 30 *CFR*, section 49.6(a).

The law also tells how your apparatus and other equipment should be maintained. It specifies how often the equipment should be checked, by whom, and how long records of these tests must be kept on file. With reference to this, the law says:

> "Mine rescue apparatus and equipment shall be maintained in a manner which will assure readiness for immediate use. A person trained in the use and care of breathing apparatus shall inspect and test the apparatus at intervals not exceeding 30 days. A record of inspections and tests shall be maintained at the mine rescue station for a period of one year."

Reference: The reference for this is 30 *CFR*, section 49.6(b).

Emergency Notification Plan

The last portion of law we'll discuss today concerns the mine's emergency notification plan. The law specifies that each mine must work out a procedure for notifying the mine rescue team during an emergency, and that this notification plan must be posted at the mine. This simply ensures that if an emergency should arise, those at the mine will know who to contact, and how.

Reference: The reference for this is 30 *CFR*, section 49.9.

What we've discussed today comes nowhere near covering everything that's included in Part 49. We've just discussed some of its major points. However, it's important for you to know about the law, because these regulations affect your team and every other mine rescue team in the country.

DEFINING MINE RESCUE

Objective 3: The team members will define mine rescue and list its objectives.

When someone says the words "mine rescue," most of us immediately think of saving lives. After all, saving lives is a very important part of mine rescue. It may even be the most glamorous or rewarding part. But saving lives is not all there is to it.

Here is a more complete definition of mine rescue: Mine rescue is the practiced response to a mine emergency situation that endangers life, property, and the continued operation of the mine.

The primary objective of mine rescue is preventing loss of life. The secondary objective is the safe recovery of the mine and its return to normal production.

Recovery

So besides saving lives, mine rescue also involves saving property so the mine can continue to operate. This is the "recovery" aspect of mine rescue. Recovery is the element most often forgotten when we talk about mine rescue. Recovery may not be such a glamorous or heroic task as saving lives, but it is still vitally important.

An effective recovery operation can save millions of dollars worth of property and production time. Perhaps more important, an effective recovery operation allows miners to return to their jobs–and paychecks–at the earliest possible date.

Team Objectives

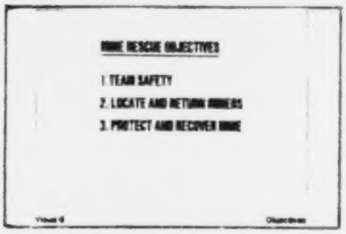
So far we've talked about saving lives and recovering property, but there's one other element of mine rescue we haven't mentioned. It is the primary consideration of any mine rescue team: The safety of its own members.

Without the team, there would be no rescue and no recovery. So team safety–even the safety of an individual member–always comes first.

Never undertake anything during a rescue that threatens the lives of the team members, regardless of how "heroic" it may seem. Losing sight of common sense in favor of heroism is foolhardy–and dangerous.

Visual: Refer to the list of objectives on "Visual 3" as you discuss this.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



MINE RESCUE OBJECTIVES

1. TEAM SAFETY
2. LOCATE AND RETURN MINERS
3. PROTECT AND RECOVER MINE

Here are the three objectives of mine rescue in the order of their importance:

1. **Team safety.**
2. **Locating trapped miners and returning them to safety.**
3. **Protecting the mine property and recovering the mine.**

These three objectives, in the order they appear here, should guide your team in everything that it does.

Note: Point out to the team that it's easy to remember the three objectives if they shorten them to three words: "team, people, property." This is a "memory-jogging" device that will help them remember the objectives even during an emergency, when more complicated definitions tend to be forgotten.

THE MINE RESCUE TEAM

Objective 4: The team members will define the mine rescue team concept and identify the tasks and procedures associated with mine rescue work.

The working unit of mine rescue, the team, is a very important concept. Simply stated, a "team" is a unit made up of individuals working toward a common goal.

A mine rescue team is composed of individuals, each with specific skills and responsibilities. The individual members must function smoothly together, almost like a well-oiled machine, in order to cope effectively with the problems and hazards that crop up during a disaster.

Like any other team, the mine rescue team has a "coach"—someone who helps the members develop skills, leads their practice sessions, and generally teaches them to be more proficient at what they do. The mine rescue team's "coach" is its team trainer.

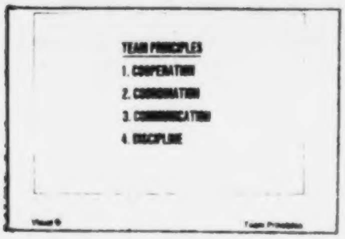
The captain of the mine rescue team has a different, but still vitally important, role to play. The captain functions as the team's on-the-field leader, much like the quarterback on a football team. The team captain "calls plays" by making decisions based on the team's abilities and the conditions they're working in. The captain leads the team and sets the pace during practice sessions and actual rescue work.

How successful any team is depends on how well its members are able to set aside personal goals for the good of the team. The same goes for mine rescue. It's important for everyone on the team to be able to set aside personality conflicts or other disagreements for the good of the whole team.

Team Principles

Visual: Refer to the principles listed on "Visual 4" as you discuss this.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



TEAM PRINCIPLES

1. COOPERATION
2. COORDINATION
3. COMMUNICATION
4. DISCIPLINE

Four key elements that go hand-in-hand with the team concept of mine rescue are: cooperation, coordination, communication, and discipline.

It's important for each team member to cooperate with others on the team. Cooperation is what makes your team a functioning unit, rather than just a disorganized group.

Coordination is another key element. It's important to coordinate what you do with what other team members are doing. This may seem difficult at first, since each team member has specific tasks, but at the same time all of them must work toward a common goal.

Your goal may be a long-range one, such as rescuing miners or recovering the mine, or it may be a more immediate objective like building a temporary stopping. Whatever the case, coordinating your moves with the rest of the team keeps the team functioning smoothly and efficiently.

You must also never forget the importance of good communication in mine rescue. Whether you're working with verbal or non-verbal commands or instructions, it's very important that you receive and interpret them properly. This is because it's absolutely essential that everyone on the team knows what to do at all times.

Listening and understanding are important elements of communication too, especially during a briefing. Learn to listen effectively so you pick up everything you need to know the first time around. During an emergency, there will probably be no time to repeat instructions.

If you listen carefully during a briefing and still don't understand something, or if some information has been left out, don't hesitate to ask questions. During an actual emergency, the lack of a single fact could be crucial in determining how well your team functions. It could even mean the difference between life and death.

Discipline is another key element in mine rescue. Discipline keeps the team working together, and it establishes a set method for doing things so that how the team functions becomes almost second nature. You don't have to actually "think" about how to proceed. It all falls into place naturally. The automatic, disciplined response of a well-trained team is especially beneficial during an emergency because it frees the team to concentrate on the work at hand.

Team Tasks

Mine rescue and recovery work involves a wide variety of different tasks. These tasks will vary from one situation to another. For example, what your team does will vary according to what type of emergency you're dealing with, and the type of mine you're entering.

Conditions within the area you plan to enter will also determine what your team will be required to do. For example, the tasks a team performs while fighting a fire in heavy smoke will probably differ from those they'd do while searching for survivors after an explosion.

During the first part of your training, you'll learn about wearing and maintaining your breathing apparatus. After that, you'll proceed to learn a wide variety of skills, tasks, and procedures that you may be called on to perform during an actual emergency.

Here's a preview of some of the types of work you may be required to do during an actual emergency:

1. Exploring the affected area of the mine
2. Searching for and rescuing survivors
3. Performing first aid
4. Determining the extent of damage
5. Determining gas conditions
6. Mapping the team's findings

7. Locating and fighting fires

8. Building temporary and/or permanent stoppings/ bulkheads

9. Erecting seals in a fire area

10. Clearing debris, pumping water, and installing or erecting temporary roof supports

You may be familiar with some of these tasks. Others will be new to you. As you might conclude after looking at this list, it's important for a mine rescue team member to be versatile. You must learn to do a very large number of things well, because you can never predict which of your skills will be most valuable during an actual emergency.

Team Procedure

Note: The following team procedure is an *example*. Keep in mind that each mine rescue situation is unique and procedures will vary.

A typical rescue or recovery operation begins on the surface with an information-gathering session known as a "briefing." During the briefing, you'll learn what happened in the mine, what has already been done, and what your team is expected to do. This is where you'll get an idea of the specific tasks you'll be required to perform once you're inside the affected area.

While you're on the surface, you'll also prepare your apparatus and check your equipment.

Next, you'll proceed inside the mine to an area known as the "fresh air base." This is a base of operations established as close as possible to the affected area of the mine, but situated where it's assured a supply of good air.

The fresh air base is the point from which you'll begin your exploration of the affected area. It's also here that communication is maintained between the team members and those outside the mine. There is a coordinator stationed at the fresh air base specifically to handle this important team-to-base communications link.

At the fresh air base, your team may receive last-minute instructions. If another team preceded yours into the affected area, you'll learn what they did, how far they traveled, and any other information relevant to your own team's task.

When it's time for your team to enter the affected area, you put on your apparatus and check to make sure they're functioning properly. Then you'll proceed on into the mine beyond the fresh air base, carrying your supplies along with you.

As your team advances, you maintain communication with the coordinator at the fresh air base, who keeps track of your progress by marking it on a mine map.

At a pre-arranged time, your team returns to the fresh air base. The captain of your team may meet briefly with the coordinator of the fresh air base and the captain of the backup team to exchange information about what your team accomplished and to make sure the map is accurately marked.

Then your team proceeds to the surface where you'll be "debriefed." During the debriefing session, you will report and discuss what your team did, saw, and found in the mine.

Team Composition

Objective 5: The team members will identify the mine rescue team composition and the roles of team members and ancillary personnel.

According to law, a mine rescue team is composed of five members and one alternate. Team composition may vary slightly from one mine to another because some teams may choose to have more than one alternate.

Reference: The legal reference for team size is 30 *CFR*, section 49.2.

All team members participate during practice sessions. However, during an emergency only five members make up the team that advances into the mine beyond the fresh air base.

Roles of Team Members

As members of a mine rescue team, each of you will be assigned specific tasks that will be your responsibility during every rescue and recovery operation. Usually, your trainer decides who does what.

Tasks are usually distributed among team members according to who is most able or best qualified to perform them.

For example, if you're skilled in a particular area of mining such as mapping or gas detection, you may be assigned to do related work on the team. Experience you've gained outside the mine, such as firefighting or emergency medical work, may also qualify you to do related work on the team.

Here are some examples of the duties that may be assigned on a typical mine rescue team:

1. Gas detection
2. Mapping
3. Communications
4. First aid
5. Firefighting
6. Construction

Note: Mention any other duties/responsibilities that will be assigned to your team.

Not all of these duties will be the responsibility of just one person. Some duties will be shared by two or more members. Some will be everyone's responsibility.

Regardless of how tasks are distributed among team members, keep in mind that the role you're assigned isn't meant to confine or restrict you in any way. It's simply meant to establish order.

Don't make the mistake of limiting yourself to learning only those tasks assigned to you. It pays to learn as many things as you can, and to know how to do all of them well. You never know when you'll be required to help someone else out, or even to switch roles with another team member.

Specific Positions

As we've seen so far, most of the positions within a mine rescue team are fairly flexible. This allows your trainer to distribute work to members according to what they do best.

However, two of the team's members—the captain and the co-captain—have very clearly defined responsibilities in addition to whatever tasks they've been assigned.

The captain and co-captain positions are key organizational elements for the team. Because these roles are more clearly defined than the others, let's take a look at precisely what these jobs entail.

Captain

Every team has a captain. This is the person who leads the team and directs the actions of the other members. As we mentioned earlier, the team captain functions as an on-the-field leader for the team, much like the quarterback on a football team.

The captain is also the team's chief decision maker. For this reason, it's important for the captain to have a general knowledge of everything that's involved in mine rescue.

Other team members may be more skilled in specific areas, but it's the captain's job to know enough about all the other areas to make effective decisions and direct the work of the entire team. Basically, the team captain oversees all the team's activities from the moment they arrive at the disaster site until they leave the final debriefing session.

It is the team captain who decides what tools, materials, and equipment the team will need. The captain also makes sure the materials are procured, and that all equipment is tested and checked before it's used.

It is the captain's job to delegate responsibility and distribute the workload among team members prior to and during the operation.

The captain is also responsible for the team's safety. This involves checking the team members' condition at regular intervals to make sure they're fit enough to continue and their apparatus are functioning properly. These team checks are made immediately after the team members put on their units, just after leaving the fresh air base, and at every rest stop during the operation.

The captain takes the first place in line, leading the team as it advances through the mine. The captain's duties as the team leader include giving signals and checking roof and rib conditions (or back and side conditions in metal/nonmetal mines) as the team progresses. The captain also regulates the pace at which the team works throughout the entire operation.

Co-Captain

The co-captain's role on a mine rescue team is also fairly well defined. The co-captain normally takes the last place in line or, in other words, "brings up the rear."

In that position, it's the co-captain's duty to keep an eye on the other members of the team to make sure they're fit, safe, and proceeding according to plan. Normally, the co-captain also checks the captain's self-contained breathing apparatus and helps the captain check the other team member's SCBA's.

Backup Personnel

In addition to the team members who advance into the affected area of the mine, several other people are needed to help out during a rescue or recovery operation. These people are just as essential to the operation as the team members themselves.

These "extras" include people such as the coordinator stationed at the fresh air base, the team alternate(s), and the team trainer.

Note: If a hoistman and/or benchman function as part of your team's backup support, be sure and mention their roles.

During an actual emergency, many others, including mine management personnel, representatives from your state's department of mines, and MSHA officials will be on hand to help organize and coordinate the rescue effort.

Note: You will be discussing how a rescue and recovery operation is organized and how the team fits into this structure in the *Surface Organization* training module (MSHA 2101 for coal, MSHA 2201 for metal/nonmetal).

YOU AS A MINE RESCUE TEAM MEMBER

Qualifications

Objective 6: The team members will identify the qualifications necessary for team membership.

Traditionally, those who've served on mine rescue teams have done so voluntarily, so there are few established qualifications for team membership. However, this doesn't mean that just anyone qualifies for team membership.

Mine rescue is a very important and serious job. It requires hard work, perseverance, and dedication. The very nature of the work requires a person with very unique qualities and capabilities.

Legal Qualifications

Mine rescue is a physically demanding profession. As a mine rescue team member, you may be called upon to work for prolonged periods under extremely strenuous conditions. In order to qualify for team membership, common sense dictates that you should have above-average stamina and strength. It's also important for a team member to have good hearing and vision.

In order to ensure that you're fit enough to withstand the rigors of mine rescue work, Federal law requires that you pass a physical examination 60 days prior to your initial training and annually thereafter. The law also specifies conditions and other criteria the physician must take into consideration during this physical.

Reference: The reference for physical requirements is 30 *CFR*, section 49.7.

Another legal requirement for team membership is one we've already discussed—prior underground work experience. According to law, you must have worked in an underground mine for at least one year within the past five years to be eligible for team membership. You also qualify if you're employed on the surface but regularly work underground.

Note: The prior work experience requirement is waived for those already on mine rescue teams when the law goes into effect.

The only other legal requirement for team membership is that you complete the 20 hours of initial mine rescue training (on the use, care, and maintenance of breathing apparatus) and meet the requirement for 40 hours of refresher training annually.

Other Qualifications

Reference: The reference for the experience requirement is 30 *CFR*, section 49.2(b).

Aside from fulfilling these Federal requirements, it's also helpful to be skilled in a particular area of mining, or to have gained expertise in mine rescue-related fields, such as firefighting or first aid.

Some of the most important qualifications for mine rescue team members are difficult to define—or even to name. Many of them are simply individual characteristics or personality traits. These are the "intangible" elements that make a good mine rescue team member.

For example, in order to be on a team, you must be dedicated and willing to sacrifice many hours in order to become proficient at what you do. You should also have a sincere interest in your undertaking.

It's also very important for every mine rescue team member to remain calm and rational—especially under pressure. This enables the entire team to function smoothly and efficiently during an emergency.

Advantages and Disadvantages of Team Membership

You will find that being on a mine rescue team has both advantages and disadvantages. To do a good job, you'll need to spend many hours practicing. The work is hard. At times, you may find this discouraging.

However, as you become more and more proficient, you'll gain confidence in your own and your team's abilities. You'll also gain increased self-respect, and the respect of others.

Note: At this point, mention any additional privileges available to your team, such as participation in contests, social functions, etc.

As a team member, you'll be responsible for rescuing miners and recovering a mine, often under very hazardous conditions. The lives of trapped miners, those of your fellow team members, and even your own life, will depend on how well you do your job.

The training program you're beginning is not just another mining course. It is a demanding pursuit, involving careful study and strenuous physical activity. It also requires a personal commitment from you to work hard, practice, and become the best team member you can possibly be.

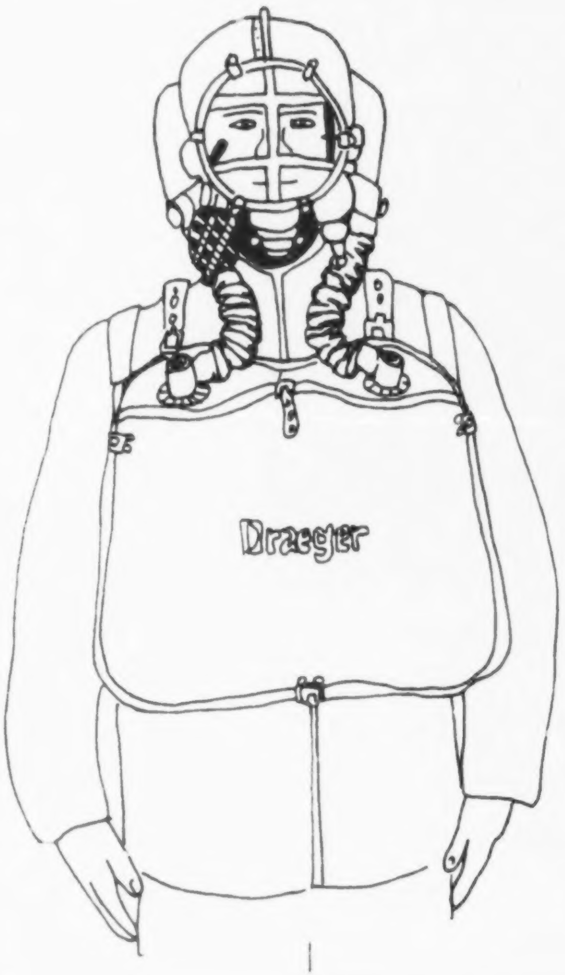
You'll have to make sacrifices–of time and energy. This is why mine rescue is voluntary. Mine rescue can also be very dangerous work. But being well-trained and conscientious can reduce the danger.

Sometimes, it may seem to you that mine rescue's sacrifices outweigh its rewards. You may get discouraged. But there are rewards.

Aside from taking part in special activities such as competitions, you can count yourself among the members of one of the most elite, highly skilled groups in the nation. You'll be engaging in activities that few others are capable of doing. You'll be performing tasks that few others would dare undertake.

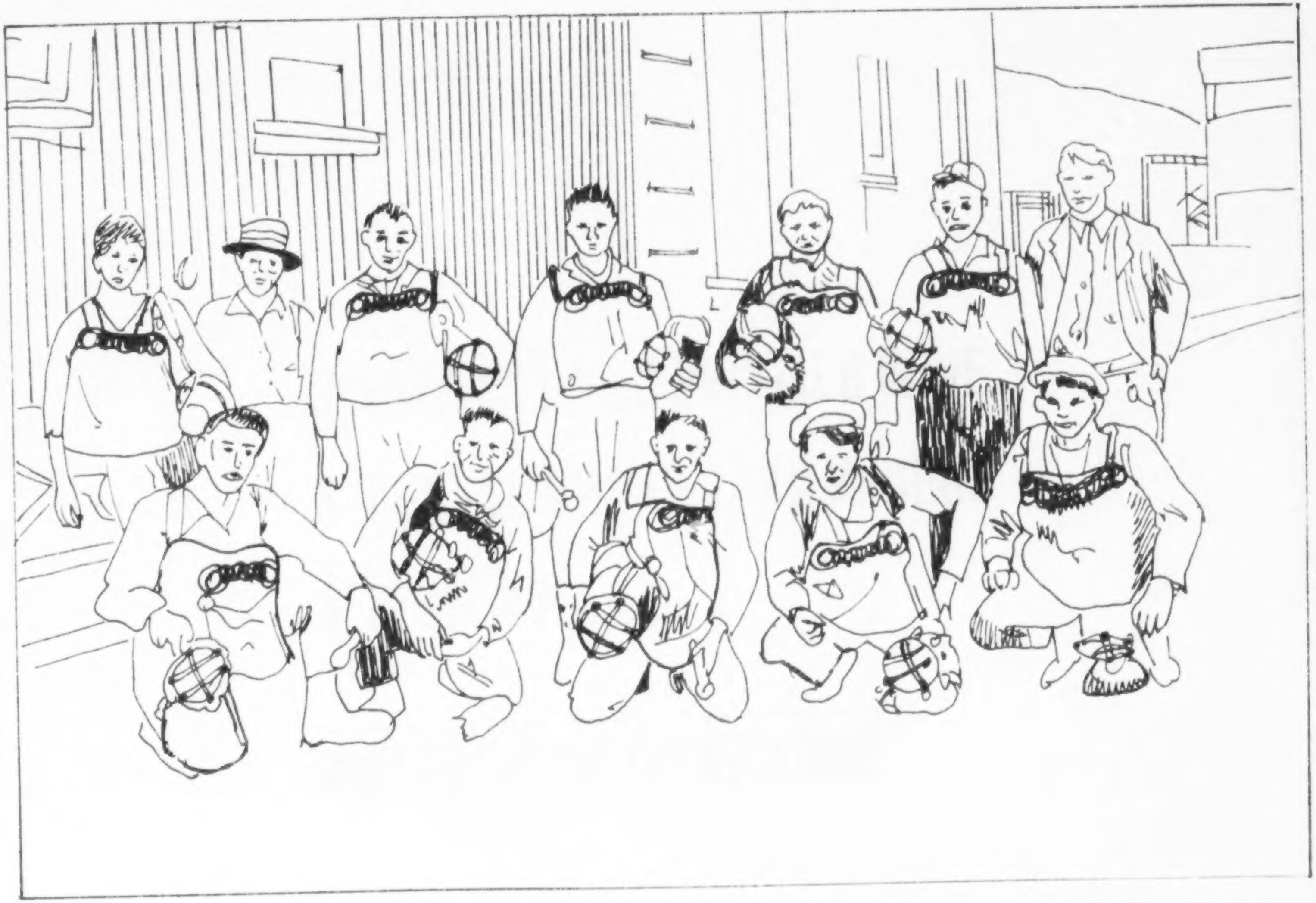
You'll also be charged with the most important responsibility a person can have–saving lives. During a disaster or other emergency, miners will depend on you.

This is why mine rescue is so serious, and why it demands your special commitment. It may be the most demanding work you've ever done–but, by its very nature, it must be. Mine rescue has no room for second best.



Visual 1

Early Draeger Apparatus



Visual 2

Early Helmet Crew

MINE RESCUE OBJECTIVES

1. TEAM SAFETY
2. LOCATE AND RETURN MINERS
3. PROTECT AND RECOVER MINE

Visual 3 Objectives

TEAM PRINCIPLES

1. COOPERATION
2. COORDINATION
3. COMMUNICATION
4. DISCIPLINE

Visual 4 Team Principles

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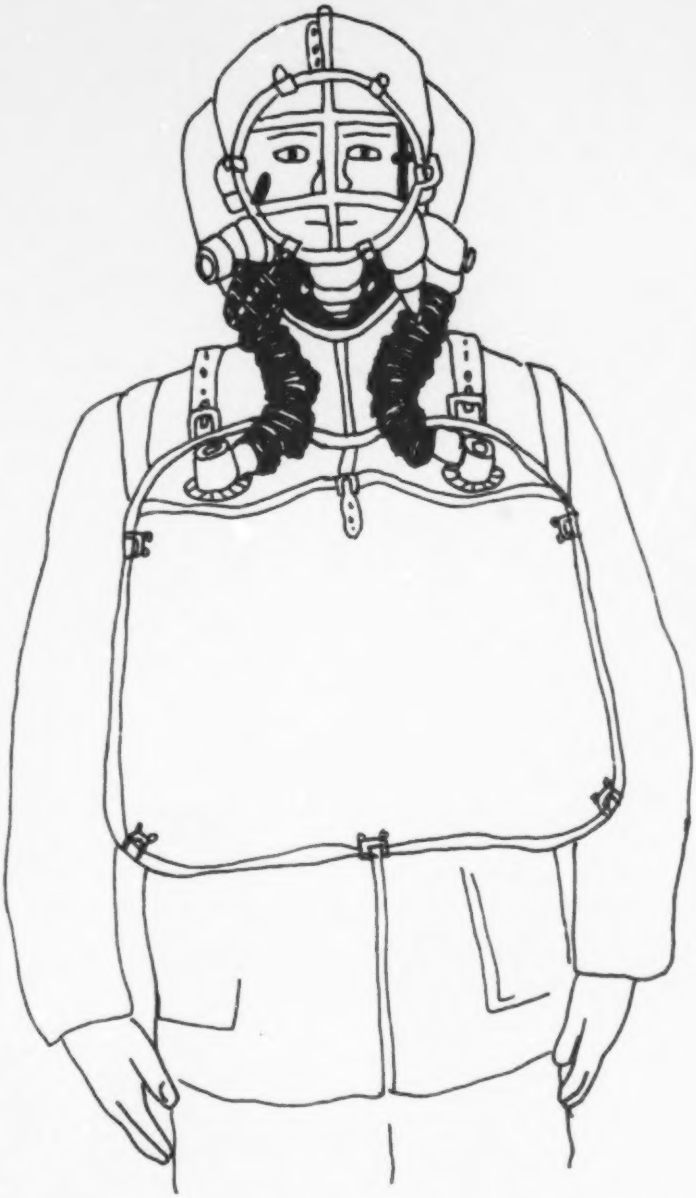
Introduction to Self-Contained Breathing Apparatus

Training Module–Initial Mine Rescue

U.S. Department of Labor
Mine Safety and Health Administration
Education and Training Directorate
November 1981

MSHA 2003



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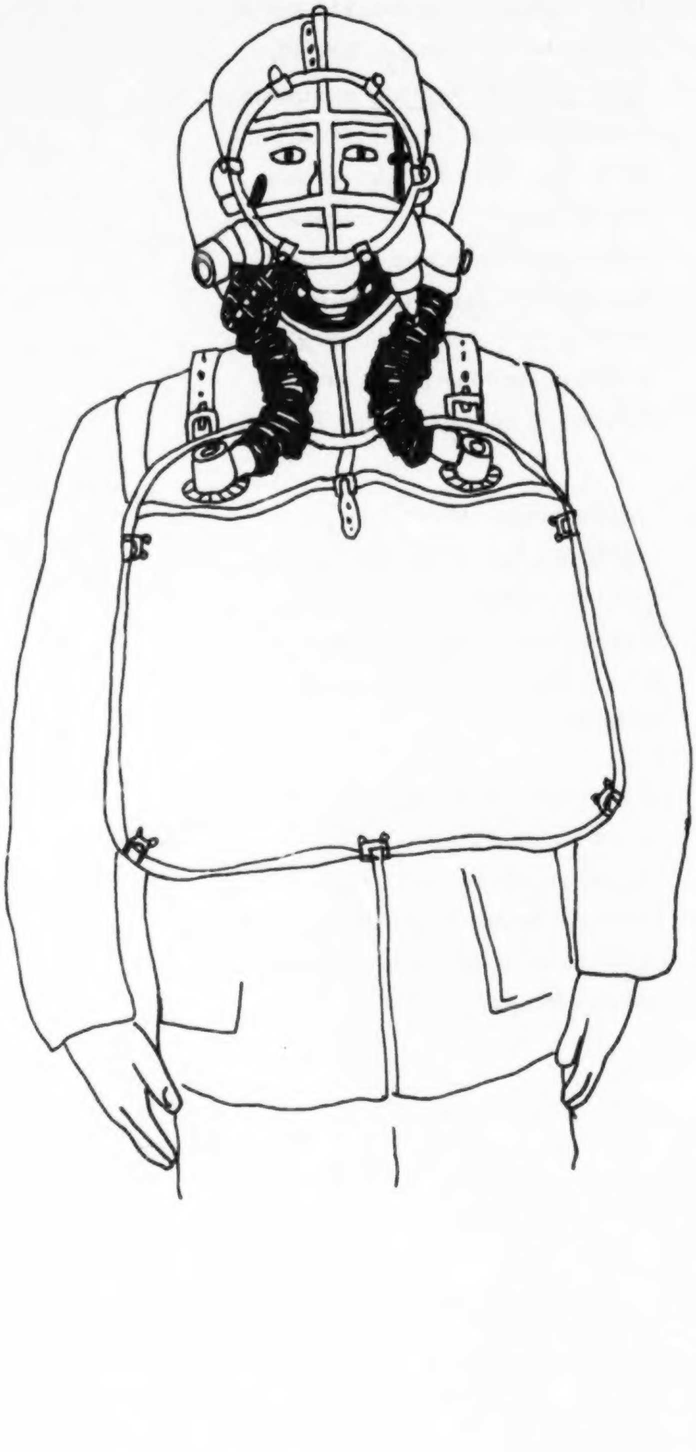

ABOUT THE TRAINING MODULES:

The modules are designed to implement the training of the Nation's mine rescue team members as mandated by Part 49, Subchapter H, Chapter 1, Title 30, Code of Federal Regulations pursuant to the Mine Safety and Health Act of 1977. Each of the modules covers a separate subject in a self-contained unit with suggested handouts and visual material to aid in its presentation. They are designed specifically for the training of underground inexperienced or experienced mine rescue team members.

Training module MSHA 2001, Instructor's Manual for Mine Rescue Training, contains a list of modules in the training program as well as a glossary that can be useful to the instructor.

This program was developed by the Mining Extension Service of West Virginia University for the Mine Safety and Health Administration under United States Bureau of Mines Contract Number JO308002.

Introduction to Self-Contained Breathing Apparatus

Training Module—Initial Mine Rescue

U.S. Department of Labor
Raymond J. Donovan, Secretary

Mine Safety and Health Administration
November 1981

MSHA 2003

Contents

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Course Objectives

Main objective

The mine rescue team member will recognize the basic types of self-contained breathing apparatus and identify the principles of their use and maintenance.

Supportive objectives

The team members will:

1. Identify the purpose and function of self-contained breathing apparatus.
2. Recognize key facts from the history of the development of self-contained breathing apparatus.
3. Identify the major differences among the basic types of self-contained breathing apparatus.
4. Identify the procedures for approval of self-contained breathing apparatus.
5. Identify the basic limitations of wearing self-contained breathing apparatus.
6. Identify the basic procedures for getting under oxygen and making team checks.
7. Identify the basic procedures for the general care and maintenance of self-contained breathing apparatus.

Course Materials

Required:

Handouts and visuals from the back of this module

Pencil and paper for each team member

Suggested:

Overhead projector

Equipment for making copies and/or transparencies

Chalkboard

Optional Resources:

Title 30 of the Code of Federal Regulations (30 CFR)

Course Outline

I. Self-contained breathing apparatus (SCBA)
    A. Description
    B. How it works

II. Development of SCBA
    A. For firefighters
    B. For miners
        1. 1853–Introduction of SCBA in mines
        2. 1880–Fleuss
        3. 1903–Draeger
        4. 1918–Gibbs
        5. 1920–Paul
        6. 1927–McCaa
        7. Apparatus today

III. Types of SCBA
    A. Open and closed circuit SCBA
    B. Primary and auxiliary SCBA
    C. Types of SCBA according to oxygen source
        1. Compressed oxygen
        2. Liquid oxygen
        3. Chemical
        4. Compressed air

IV. Apparatus approval
   A. Former Schedule 13 approval (Bureau of Mines)
   B. Current NIOSH/MSHA approval
   C. Approval labels

V. Wearing the apparatus
   A. Conditions when the apparatus won't protect you
   B. Limitations of wearing an apparatus
      1. Time limit, work rate, and breathing rate
      2. Weight and size of apparatus
      3. Seeing
      4. Speaking
      5. Facepiece seal
      6. Others
   C. Getting under oxygen
   D. Team checks

VI. Care and maintenance of apparatus
   A. Testing and inspecting
   B. Cleaning

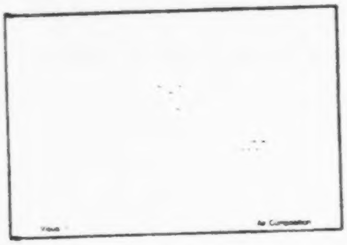
Instructor Notes

Note: This module is provided as an introduction to the self-contained breathing apparatus that the team will be using. It covers general information about self-contained breathing apparatus and should be followed by the module on the specific apparatus that the team will be using.

Objective 1: The team members will identify the purpose and function of self-contained breathing apparatus.

Visual: Refer to "Visual 1" for a pie graph showing air composition as you discuss the following section.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Suggested Lecture

SELF-CONTAINED BREATHING APPARATUS (SCBA)

A self-contained breathing apparatus is a completely portable unit that supplies you with oxygen or air independently of the surrounding atmosphere.

Normal air contains approximately 21 percent oxygen, 78 percent nitrogen, and 1 percent carbon dioxide and other gases.

Note: Other gases include argon, and trace amounts of neon, helium, krypton, xenon, hydrogen, methane, nitrous oxide, and ozone.

Nitrogen, taking up such a large volume of air, is an inert (inactive) gas; it does not harm your lungs nor is it absorbed by your lungs. It simply moves in and out of your lungs as you breathe.

Visual: Refer to "Visual 2" for a drawing showing oxygen consumption as you discuss the following section.

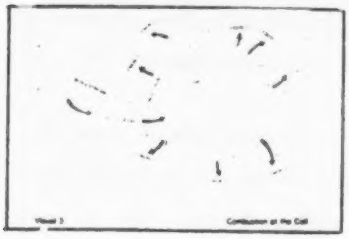
Use this visual as an overhead transparency, chalkboard sketch, or handout.

21% O_2
Visual 2
Oxygen Consumption

Oxygen on the other hand, is the gas that our bodies need in order to stay alive. When we breathe in and out, we essentially take in the needed oxygen and then expel the waste gas–carbon dioxide–from our bodies.

Visual: Refer to "Visual 3" while you discuss the following section.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Oxygen is needed in all the cells in our bodies in order to support combustion and thereby produce energy. The fuel for the fire, so to speak, is food that has been digested and converted to glucose. The glucose and oxygen combine in a combustion process and energy is produced.

Then the carbon dioxide, which is a byproduct of the combustion process, is picked up by the bloodstream and is transferred from the blood to the lungs, where it is exhaled to the outside atmosphere. So you can see just how important oxygen is in producing the energy to keep us alive.

When your team is called out to a mine emergency and enters the mine to explore it, you could be entering air which is not safe to breathe—air which could have high concentrations of carbon monoxide (CO), a deadly, odorless gas—or simply air that does not have enough oxygen to keep you alive. There might also be other dangerous gases in the mine.

Therefore your team must carry its own supply of good air to breathe in the mine and that is what the self-contained breathing apparatus is for. The self-contained breathing apparatus supplies you with safe air to breathe and removes the carbon dioxide from your exhaled breath so that you can continue to inhale from and exhale into the apparatus independent of the surrounding air.

The apparatus is essentially a second pair of lungs to act with your lungs to create a closed circuit. Your lungs absorb oxygen and produce carbon dioxide. The apparatus absorbs carbon dioxide and produces oxygen.

DEVELOPMENT OF SCBA

Objective 2: The team members will recognize key facts from the history of the development of self-contained breathing apparatus.

The history of the development of self-contained breathing apparatus goes quite far back in time, though in the early days most of the attention was given to designing a unit to protect firemen from smoke inhalation.

Visual: Refer to "Visual 4" for a drawing of the smoke filter as you describe it in the following section.

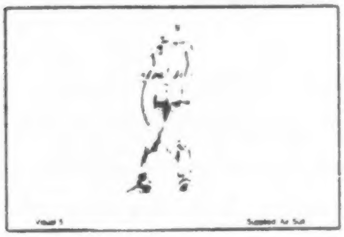
Use this visual as an overhead transparency, chalkboard sketch, or handout.

One such design for firemen dates back to about 1825 when the "smoke filter" was used. It consisted of a leather hood and a hose that was strapped to one of the wearer's legs. It did not contain its own supply of oxygen. Rather, it was designed so that when the wearer inhaled from inside the hood, air would be drawn up through the hose.

The idea behind this design was that the best air during a fire is closest to the floor. The hose and hood was intended to provide this better air to the firemen as they worked in smoke.

Visual: Refer to "Visual 5" for a drawing of the supplied-air suit as you describe it below.

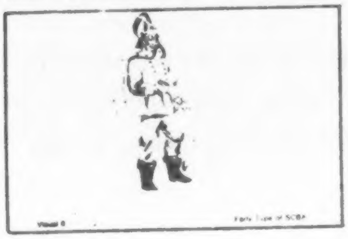
Use this visual as an overhead transparency, chalkboard sketch, or handout.



Soon after, equipment was designed to provide the firemen with good safe air to breathe for short periods of time. One such design was the "supplied-air suit" which was filled with fresh air to breathe.

Visual: Refer to "Visual 6" for a drawing of another type of apparatus that is described below.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



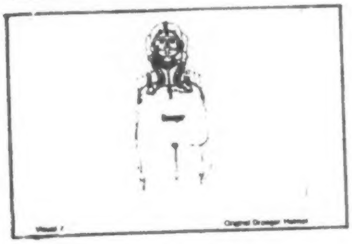
Another design for firefighters was a bag-like unit filled with fresh air and carried on one's back, much like some of today's units.

Underwater divers also used some of the first self-contained breathing apparatus developed.

Then, in 1853, self-contained breathing apparatus was introduced for use in the mines by a Professor Schwann of Belgium. In that year, Schwann entered a self-contained breathing apparatus in a competition of the Belgian Academy of Science, and exhibited it at an industrial fair in Belgium.

Visual: Refer to "Visual 7" for a drawing of the original Draeger apparatus as you describe it below.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



In 1880, the original Fleuss apparatus was introduced in England, and in 1903 the original Draeger apparatus was developed in Germany.

In the United States, breathing apparatus were introduced in 1907 when five Draeger units were purchased by the Boston and Montana Mining Company in Butte, Montana.

Records show that also in 1907, apparatus were first used to fight fires and explore ahead of fresh air in the mines:

1. In October or November of 1907, Draeger apparatus were used by a crew of men during the fighting and sealing of a mine fire at the Minnie Healy Mine of the Boston and Montana Mining and Smelting Company in Butte, Montana.

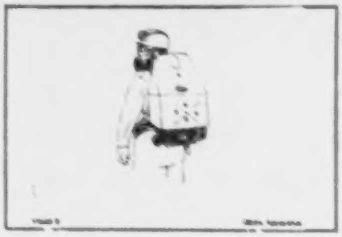
2. On December 6, two Draeger apparatus were used to explore ahead of fresh air after an explosion in the Monongah Mine of the Consolidated Coal Company in Monongah, West Virginia.

3. On December 19, apparatus were used after an explosion in the Darr Mine of the Pittsburgh Coal Company in Jacobs Creek, Pennsylvania.

In 1910, the Bureau of Mines was established. The Bureau began equipping mine rescue railroad cars and stations with apparatus and began training miners in the use and care of the breathing apparatus. Thus, the equipment necessary for rescue work and the trained teams to use it gradually became more available to the mines.

Visual: Refer to "Visual 8" for a drawing of the Gibbs apparatus as you mention it below.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



At first, all the apparatus used in this country were imported from Europe. Then in 1918, the Gibbs apparatus was designed and manufactured. This was followed by the Paul in 1920 and the McCaa in 1927. These early American-made apparatus were designed for 2-hour use.

The development of self-contained breathing apparatus has continued to progress through the years. A number of different manufacturers are now producing apparatus that are approved to be used for periods of 2, 3, and 4 hours at a time. Among these apparatus commonly used for mine rescue work are the Draeger BG 174, the Aerorlox, and the Scott Rescue-Pak.

TYPES OF SCBA

Objective 3: The team members will identify the major differences among the basic types of self-contained breathing apparatus.

READEX FICHE

Open and Closed Circuit SCBA

Self-contained breathing apparatus can be divided into two main categories: open circuit systems and closed circuit systems. The basic difference between the two systems is this: An open circuit system releases all of your exhaled air (carbon dioxide) to the outside atmosphere through a valve in the facepiece, and supplies you with fresh air to breathe.

A closed circuit system does not release the exhaled air. Rather, it recirculates the air through the apparatus and purifies the air, taking out the carbon dioxide and adding fresh oxygen to the air. You are then supplied with the air that has been oxygen enriched.

Primary and Auxiliary SCBA

In mine rescue work, apparatus are classified as being either "primary" or "auxiliary" apparatus depending on how much air or oxygen they can supply to you when you wear them. Primary apparatus are apparatus that have a minimum of 2 hours' service time. Auxiliary apparatus are units which provide, by law, 30 to 60 minutes' service time.

Reference: The reference for the above-mentioned law is Title 30, *Code of Federal Regulations* (30 *CFR*), Section 11.70(c)(d).

Primary apparatus are the standard apparatus that mine rescue teams use. Part 49 of Title 30 of the Code of Federal Regulations (30 CFR) specifies that rescue teams must be provided with self-contained breathing apparatus that have at least a 2-hour service time and are approved under Federal guidelines.

Reference: The reference for the abovementioned law is 30 *CFR*, Section 49.6(a).

The Federal guidelines for apparatus approval are contained in 30 *CFR*, Part 11, Subpart H.

Reference: The reference for the abovementioned regulation is 30 *CFR*, Section 11.3.

Reference: For further information regarding auxiliary apparatus, refer to the *Introduction to Auxiliary Apparatus* training module (MSHA 2008).

Review questions: Ask the team members the following questions. Then discuss the correct answers with the team so they fully understand the material covered thus far.

1. Explain generally how a self-contained breathing apparatus works.

   (Answer: A self-contained breathing apparatus provides oxygen or safe air to breathe, and has a means of removing carbon dioxide from the exhaled air, so that the wearer can breathe independently of the surrounding air.)

Auxiliary apparatus are only acceptable for a mine rescue team member to use so long as the team member has ready access to fresh air and has at least one rescue team equipped with an approved self-contained breathing apparatus of 2-hours or longer rating in reserve at the fresh air base.

Auxiliary apparatus may either be open or closed circuit systems. Primary apparatus, on the other hand, are designed as closed circuit systems.

2. Why would you need to wear a self-contained breathing apparatus?

(**Answer**: If you were entering a mine in which the air could be bad, for example, air with large amounts of carbon monoxide, smoke, or not enough oxygen.)

3. What is the basic difference between an open circuit apparatus and a closed circuit apparatus?

(Answer: An open circuit apparatus *releases all the wearer's exhaled air* (thus the carbon dioxide) to the outside, and *supplies fresh air* to the wearer.

A closed circuit apparatus *recirculates the exhaled air, taking out the carbon dioxide* and *adding fresh oxygen to the air*, so that the wearer can inhale the purified, oxygen-enriched air.)

Types of SCBA According to Oxygen Source

All apparatus can be divided and classified as one of four basic types depending on what source of oxygen or air is used. The four types of self-contained breathing apparatus are:

1. Compressed oxygen;
2. Liquid oxygen;

3. Chemical; and

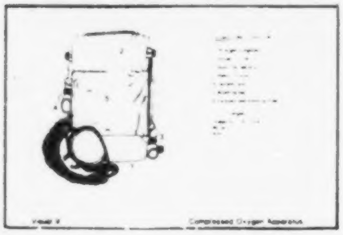
4. Compressed air.

Compressed Oxygen Apparatus

(Closed Circuit System)

Visual: Refer to "Visual 9" for a drawing of the basic components of a compressed oxygen apparatus. Point out the following parts as you describe them in the lecture.

Use this visual as an overhead transparency, chalkboard sketch, or handout



The source of oxygen in a compressed oxygen apparatus is an oxygen cylinder which contains the oxygen under very high pressure.

To remove the carbon dioxide in this closed circuit system, a chemical known as soda lime is used. This chemical, which resembles vermiculite, must be put into the apparatus before each use.

When you exhale, air is forced through the soda lime where the carbon dioxide is absorbed, leaving the rest of the air to exit in a purified state.

Other principal components of the compressed oxygen apparatus are:

1. An oxygen pressure reducing valve and an oxygen demand valve for regulating the flow of oxygen from the high-pressure cylinder to you;
2. A breathing bag to serve as a reservoir of oxygen-enriched air ready to be inhaled; and
3. A facepiece and breathing hoses.

Examples of compressed oxygen apparatus and their service times are:

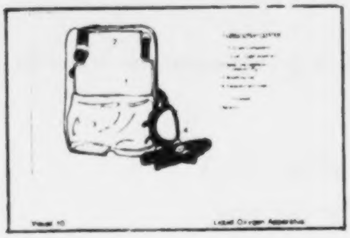
1. Draeger BG 174 and BG 174-A
   2-, 3-, and 4-hour service time;
2. McCaa
   2-hour service time;
3. Scott Rescue-Pak
   4-hour service time; and
4. BioPak
   30-minute or 60-minute service time.

Liquid Oxygen Apparatus

(Closed Circuit System)

Visual: Refer to "Visual 10" for a drawing of the basic components of a liquid oxygen apparatus. Point out the following parts as you describe them in the lecture

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Liquid oxygen is the source of oxygen in a liquid oxygen type of apparatus. The liquid oxygen is contained in a unit of the apparatus known as an evaporator, where the liquid vaporizes into a gas.

Soda lime is used to remove carbon dioxide in this closed circuit system. The soda lime absorbs the carbon dioxide as exhaled air is forced through it. The rest of the air leaves the soda lime in a purified state, safe to rebreathe when mixed with fresh oxygen from the evaporator.

Other principal components of the liquid oxygen apparatus are:

1. A breathing bag to serve as a reservoir of oxygen-enriched air; and
2. A facepiece and breathing hoses.

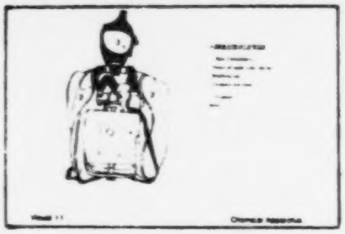
An example of a liquid oxygen apparatus is the Aerorlox apparatus, which has a 3-hour service time.

Chemical Apparatus

(Closed Circuit System)

Visual: Refer to "Visual 11" for a drawing of the basic components of a chemical apparatus. Point out the following parts as you describe them in the lecture.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



In a chemical apparatus, a potassium superoxide canister is both the source of oxygen and the means of removing the carbon dioxide. Other principal components of the chemical apparatus are:

1. The breathing bag; and

2. The facepiece and breathing hoses.

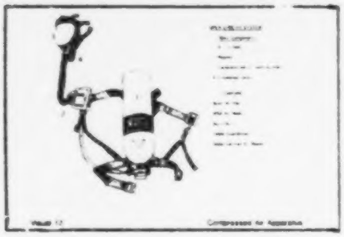
An example of a chemical apparatus is the Chemox, with a 1-hour service time.

Compressed Air Apparatus

(Open Circuit System)

Visual: Refer to "Visual 12" for a drawing of the basic components of a compressed air apparatus. Point out the following parts as you describe them in the lecture.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



An air cylinder filled with air under high pressure is the source of air in a compressed air apparatus. And, being an open circuit system, the carbon dioxide is removed when you exhale all the exhaled air to the outside atmosphere through an exhalation valve.

A compressed air apparatus also contains:

1. A regulator for reducing the pressure and regulating the flow of air from the high-pressure air cylinder to you; and
2. A facepiece and a breathing hose.

Examples of compressed air apparatus are:

1. Scott Air-Pak
   30-minute service time;

2. MSA Air Mask
   30-minute service time;

3. SurvivAir
   30-minute service time;

4. Globe Guardsman
   30-minute service time; and

5. Siebe Gorman Air Master
   30-minute service time.

APPARATUS APPROVAL

Objective 4: The team members will identify the procedures for the approval of self-contained breathing apparatus.

In order for any self-contained breathing apparatus to be used in mine rescue work, the apparatus must first be approved by the Federal government.

Back in 1918, the Bureau of Mines began to test and approve apparatus under Schedule 13 which established the standards for approval.

Today, the testing of the apparatus is handled by the National Institute for Occupational Safety and Health (NIOSH). The apparatus approval is granted jointly by NIOSH and the Mine Safety and Health Administration (MSHA).

To receive NIOSH and MSHA approval, self-contained breathing apparatus must meet specific requirements as to design and construction, and must operate satisfactorily during a specified series of actual wearing tests. The exact requirements for approval are outlined in Title 30, of the Code of Federal Regulations (30 CFR), Part 11.

Certain apparatus approved formerly under Schedule 13 by the Bureau of Mines have been "conditionally approved" under 30 CFR and can still be used if manufactured and purchased before June 30, 1975, and if the apparatus has been properly maintained.

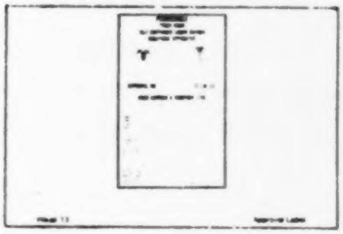
The McCaa apparatus is an example of an apparatus approved under Schedule 13 and still acceptable for mine rescue work.

Reference: Refer to 30 *CFR*, Section 11.2 for information regarding Schedule 13 approval.

Approval Labels

Visual: Refer to "Visual 13" for a picture of an approval label.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Reference: The reference for the following law is 30 *CFR*, Section 11.33.

All approved apparatus are required by law to display an approval label on the unit. This label must bear the MSHA label and the seal of NIOSH, an approval number, and the name of the apparatus's manufacturer.

In addition to this, the label tells:

1. The type of apparatus (compressed oxygen, liquid oxygen, and so forth);
2. The approved service time of the apparatus (for instance, 2 or 3 hours);
3. The part numbers for component parts approved to be used with the apparatus (such as the facepiece part number or the breathing bag part number);
4. The limitations of the apparatus (such as the temperature range for use of the apparatus); and
5. Any special precautions that should be taken while using the apparatus.

An apparatus approved under Schedule 13 will not have a current NIOSH/MSHA approval label on it. However, the apparatus should carry a Bureau of Mines approval label, bearing the seal of the Bureau and listing information similar to that on the current NIOSH/MSHA approval labels.

All approval labels should be read carefully so that the apparatus can be used in an approved manner. Also, if you should ever be in a situation where you are using an apparatus which is new to you (perhaps another team's equipment), the label will give you some basic information to help familiarize you with the apparatus.

WEARING THE APPARATUS

Objective 5: The team members will identify the basic limitations of wearing self-contained breathing apparatus.

When you enter a mine as a mine rescue team, you may find yourself in smoke or poisonous gases, or not enough oxygen to keep you alive. That is why you wear an apparatus in mine rescue work. The apparatus will protect your lungs from smoke and poisonous gases, and provide safe air for you to breathe.

There are, however, some conditions under which the apparatus will not entirely protect you:

1. Self-contained breathing apparatus will not protect you from toxic amounts of poisonous gases, dusts, or vapors that may injure your skin or be absorbed through your skin into your system. For example, fairly high concentrations of ammonia will injure your skin and hydrogen cyanide can be absorbed through your skin.

2. Your apparatus will not protect you if it is worn extensively in petroleum vapors. These vapors will permeate and deteriorate the rubber parts of the apparatus.

3. In air which is much above normal atmospheric pressure (14.7 pounds per square inch), it can be dangerous to wear an apparatus that supplies you with pure or nearly pure oxygen. Special precautions and procedures from the apparatus's manufacturer which allow the safe use of breathing apparatus under high atmospheric pressure should be followed.

Limitations of Wearing an Apparatus

Wearing any apparatus has its limitations. That is, there are things it cannot do and special factors you should take into consideration when you wear it.

In general, seeing, speaking, moving, working, and breathing are all a little different when you are wearing the apparatus. Understanding these differences and learning to cope with them can have a significant affect on how well you do your job.

Apparatus designed by various manufacturers are all going to be a bit different. You will be practicing wearing and working with your apparatus so that you can get used to the feel of it and how it works.

For now, we will talk generally about what it's like to wear an apparatus and what the general limitations are.

Visual: Refer to "Visual 14" for a listing of the general limitations as you discuss the following section.

Use this visual as an overhead transparency, or handout, or write out the information on a chalkboard.

Time Limit, Work Rate, and Breathing Rate

Any self-contained breathing apparatus that you use will limit the time you'll have in which to work underground. Your apparatus will be approved for a specified amount of time per wearing called the "service time."

The service time is established assuming that you work at a moderate rate. If you work extremely hard, you will be breathing faster and you will be consuming your oxygen or air at a faster rate. Also, nervousness or excitement can cause you to breathe faster and use more oxygen. In addition, the roughness of the terrain you must travel and the heat and humidity of the area you will be in can affect your breathing rate and consequently, the service time.

You should try to avoid breathing too quickly while wearing the apparatus. Short, shallow breathing or panting causes you to get an insufficient amount of oxygen and you may begin to feel faint. So if you find yourself breathing quickly, try to control your breathing and slow it down.

Also, you will probably experience some resistance to breathing while wearing the apparatus' facepiece. This is caused by the air pressure in the facepiece. With practice and familiarity with the apparatus, you should be able to compensate for this resistance.

Weight and Size of Apparatus

Reference: The reference for the following specification is 30 *CFR*, Section 11.85-4.

The requirements for apparatus approval specify that an apparatus can weigh up to 40 pounds. This extra weight you will be carrying will affect your endurance, your rate of work, and your maneuverability. Therefore you will have to practice working with the apparatus on so that you can get used to moving and working with the extra weight and bulk.

One thing to remember while wearing the apparatus: All your movements should be slow and deliberate.

Seeing

Reference: The reference for the following requirement is 30 *CFR*, Section 11.76.

The requirements for apparatus approval specify that facepieces be designed and constructed to provide adequate vision. Still, when you wear the facepiece, you will find yourself turning your head and body more often than usual to see things around you.

Remember again: All movements while wearing the apparatus should be slow and deliberate.

Also, the heat and moisture produced within some of the apparatus can cause the facepiece to fog, making it difficult for you to see. Yet there are special "anti-fog" solutions that can be applied to the facepiece lens to help prevent it from fogging up on you.

Speaking

It is going to be more difficult to communicate while wearing the facepiece because your voice will be distorted. All the facepieces have a speaking diaphragm to transmit your voice to the outside of the facepiece but they tend to muffle your voice. You may find yourself having to speak a little louder and slower than usual in order to be understood.

Also, you should try to talk as little as possible while wearing the apparatus. This means to cut out all unnecessary "chatter" so that only important information is communicated.

Facepiece Seal

When you wear the facepiece, it is extremely important to have a good tight seal around your face. This is known as the face-to-facepiece seal, or simply as the facepiece seal.

Note: If the team will be using a mouthpiece, stress the importance of having a good mouthpiece seal.

A good seal will prevent smoke and poisonous gases from leaking into the facepiece and infiltrating your air supply. It will also prevent any inadvertent leak of oxygen or air from inside the facepiece to the outside atmosphere. So it is very important to tighten your facepiece snugly to your face and test it to make sure there aren't any leaks.

Such things as very prominent cheekbones or deep scars could prevent a good seal. Other conditions that prevent a good facepiece seal are: (1) eyeglasses, and (2) beards and bushy sideburns, which are not recommended to be worn with any breathing apparatus.

Eyeglasses can prevent a good face-to-facepiece seal and should not be worn with many types of facepieces. Sometimes, however, eyeglasses will fit within the facepiece without disturbing the facepiece seal. Some facepieces even allow for the insertion of corrective lenses directly into the facepiece.

Also, wearing contact lenses with the facepiece on is considered very hazardous even though they don't prevent a good facepiece seal. There is evidence that contact lenses may become lodged above the eye due to pressure in the facepiece, so they should not be worn.

Note: If the team uses a mouthpiece, explain that dentures or missing teeth may present problems in getting a good mouthpiece seal.

Other Limitations

Each apparatus, of course, will have its own limitations. The temperature of the breathing air will vary–some cool, others warm and moist.

Each apparatus will be approved to be worn only in a certain temperature range.

These and all the other specific limitations will be covered when we go over the ____________________
(Insert name of team's apparatus)
apparatus in more detail.

Review questions: Ask the team members the following questions. Then discuss the correct answers with the team so they fully understand the material covered in the "Limitations" section.

1. Why is a good facepiece seal important?

   (Answer: A good seal will prevent smoke and poisonous gases and fumes from leaking into the facepiece and infiltrating the oxygen supply and will prevent loss of breathing air from inside the facepiece.)

2. List some of the things that can interfere with a good face-to-facepiece seal.

   (Answer: Eyeglasses, deep scars, beards, bushy sideburns, large cheekbones.)

3. List three other limitations associated with wearing the apparatus.

(Answer: A breathing apparatus will:

(1) Limit the time in which you have to work.

(2) Restrict your maneuverability.

(3) Restrict your peripheral vision.

(4) Make communication more difficult.)

Objective 6: The team members will identify the basic procedures for getting under oxygen and making team checks.

Getting Under Oxygen

Getting under oxygen refers to the process of putting on your apparatus and making sure it is functioning properly. Procedures for getting under oxygen will vary according to the type of apparatus you're using.

Before putting on the apparatus you should make sure it has been properly tested and properly prepared for use. You should also check over the apparatus to make sure it is in good condition.

Some of the things you should check are the condition of the wearing harness straps and the condition of the facepiece and hoses. You should also check to see if you have a fresh supply of the carbon dioxide absorbent in the apparatus and a proper supply of oxygen or air.

Then you would put on the apparatus a "get under oxygen."

These are just a few of the things you'll be checking before you put on the apparatus. Each type of apparatus will have its own procedure for getting under oxygen and we will talk about them when we discuss the

____________________________ apparatus in more detail.
(Insert name of team's apparatus)

It is a good idea to get under oxygen together, as a team, so that everyone will be doing the same thing at the same time.

Note: Many teams have found that the best way to get under oxygen together is by counting off as each step is completed satisfactorily. The captain calls out each step, and the team members respond as they complete each check. For instance, the captain will announce, "check facepiece seal," and each team member will check the seal and report back, separately, "Number 1 man okay, Number 2 man okay," etc.

"Visual 15" gives a sample list of procedures for getting under oxygen. You may wish to refer to it.

Use this visual as an overhead transparency or handout, or write out the information on a chalkboard.

Team Checks

Once you have put on the apparatus and are under oxygen, the team captain should check you and the other team members to make sure that you feel okay and are ready to go, and to make sure that your apparatus is on correctly and is functioning properly. Another designated team member, in turn, should check the captain.

These checks are known as "team checks" and they should be done right after you've gotten under oxygen and also periodically as you work under oxygen.

The exact checks that should be made while working under oxygen depend again on the type of apparatus being used. For instance, with a compressed oxygen apparatus, the captain would check your pressure gauge to see how much oxygen you have consumed. You will find out more about these particular checks when we discuss the

________________________________ apparatus in more
(Insert name of team's apparatus)

detail.

Note: Each apparatus module contains a "Wearing Schedule" which explains the team checks in more detail.

Rescue work is a team effort. Every one of you on the team and your apparatus must be in good shape and you must remain in good shape when you're underground. If any one of you have trouble while you're underground, it is essential to inform the team captain. The captain will then decide what needs to be done according to the situation.

If someone must return to fresh air because of a problem, it is a standard practice among teams for the entire team to go back with that person. No one should ever travel alone.

CARE AND MAINTENANCE OF APPARATUS

Objective 7: The team members will identify the basic procedures for the general care and maintenance of self-contained breathing apparatus.

Reference: The reference for the following law is 30 *CFR*, Section 49.6.

According to Federal regulations, breathing apparatus must be inspected and tested at intervals not exceeding 30 days. They must be inspected and tested by a person trained in the use and care of the apparatus in accordance with the manufacturer's recommendations. Also, where applicable, cylinder pressure must be maintained at all times.

You are further required to keep a record of all the tests and inspections performed on each apparatus. This record must be initialed by the person making the tests and inspections, and it must be kept on file at the mine rescue station for a period of one year.

Note: Some teams have a benchman to test and maintain the apparatus for the team. On other teams, the team members themselves are responsible for testing and maintaining their own apparatus.

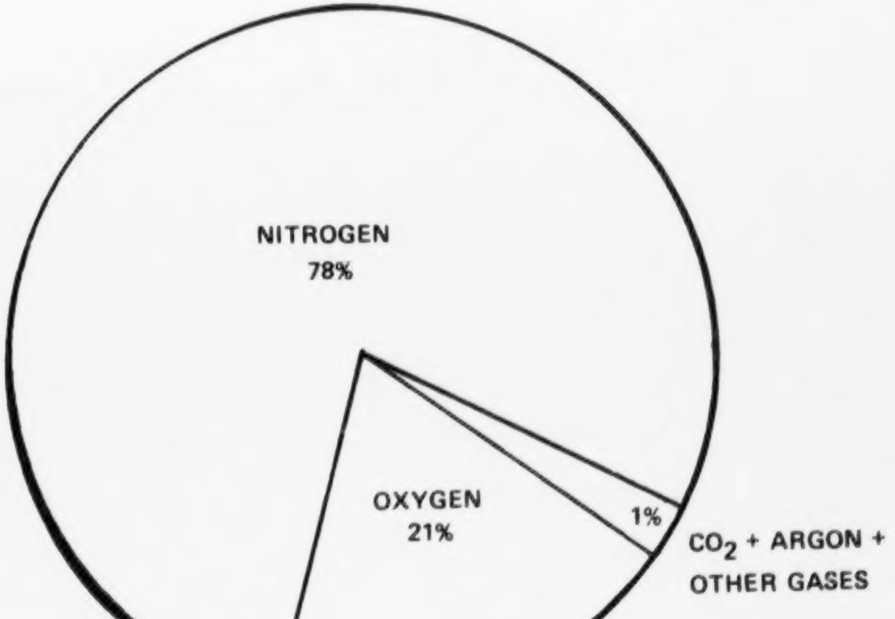
Each manufacturer specifies the testing and maintenance procedures that should be followed on the apparatus. You will be learning about these specific procedures when we go over the ______________________________ apparatus in more detail.
(Insert name of team's apparatus)

In addition to testing and maintaining the apparatus to make sure that it's okay, it is important to keep the apparatus clean so that all the parts, especially the rubber parts, will last a long time. This means cleaning and disinfecting the apparatus after each use, allowing it to dry properly and completely, and storing the apparatus in its storage box to protect it from dirt and moisture.

It is very important that you understand how your apparatus works and that you trust it to be in perfect condition because when you wear the apparatus in unsafe air, you are depending on every part of it to keep you in your own zone of safe air.

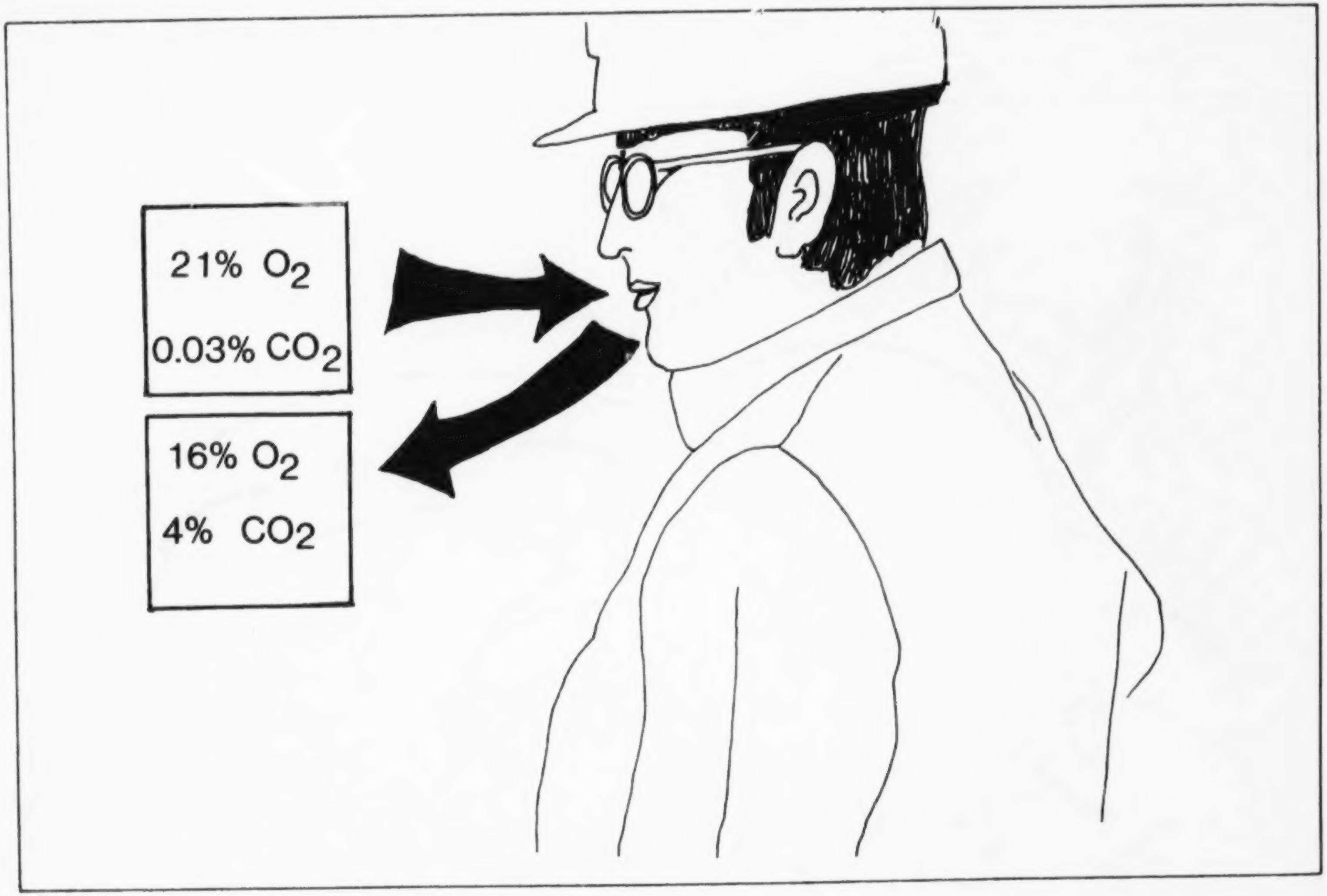
When we go over the ______________________________
(Insert name of team's apparatus)

apparatus in more detail, be sure to ask any questions you may have so that you completely understand the use of your apparatus.

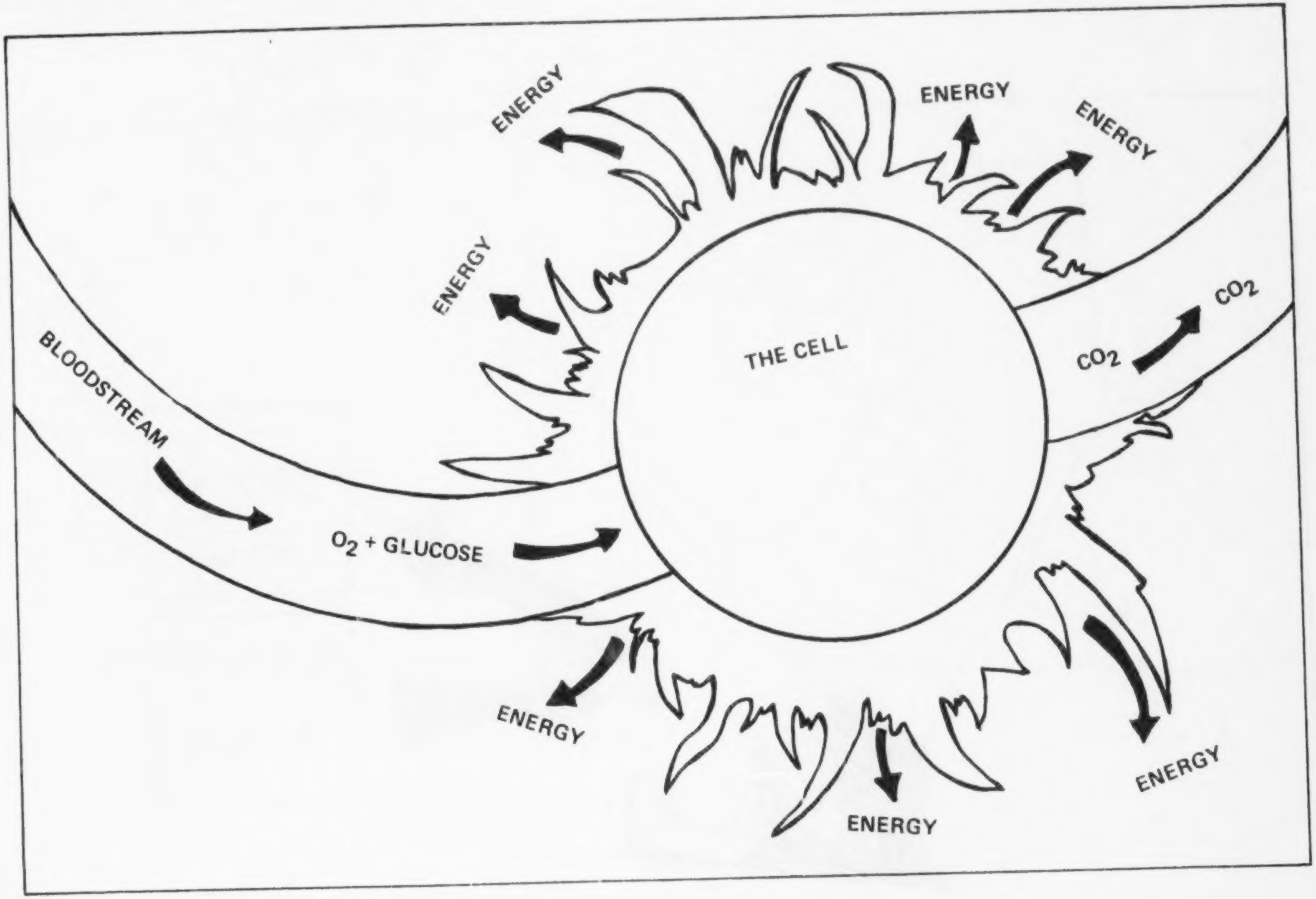


Visual 1

Air Composition

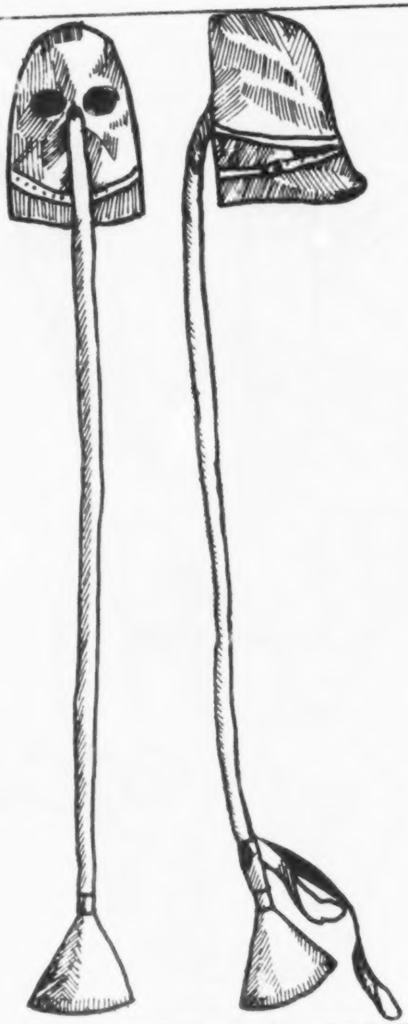

21% O_2
0.03% CO_2
16% O_2
4% CO_2

Visual 2 Oxygen Consumption


ENERGY
ENERGY
ENERGY
ENERGY
BLOODSTREAM
THE CELL
CO_2
CO_2
O_2 + GLUCOSE
ENERGY
ENERGY
ENERGY

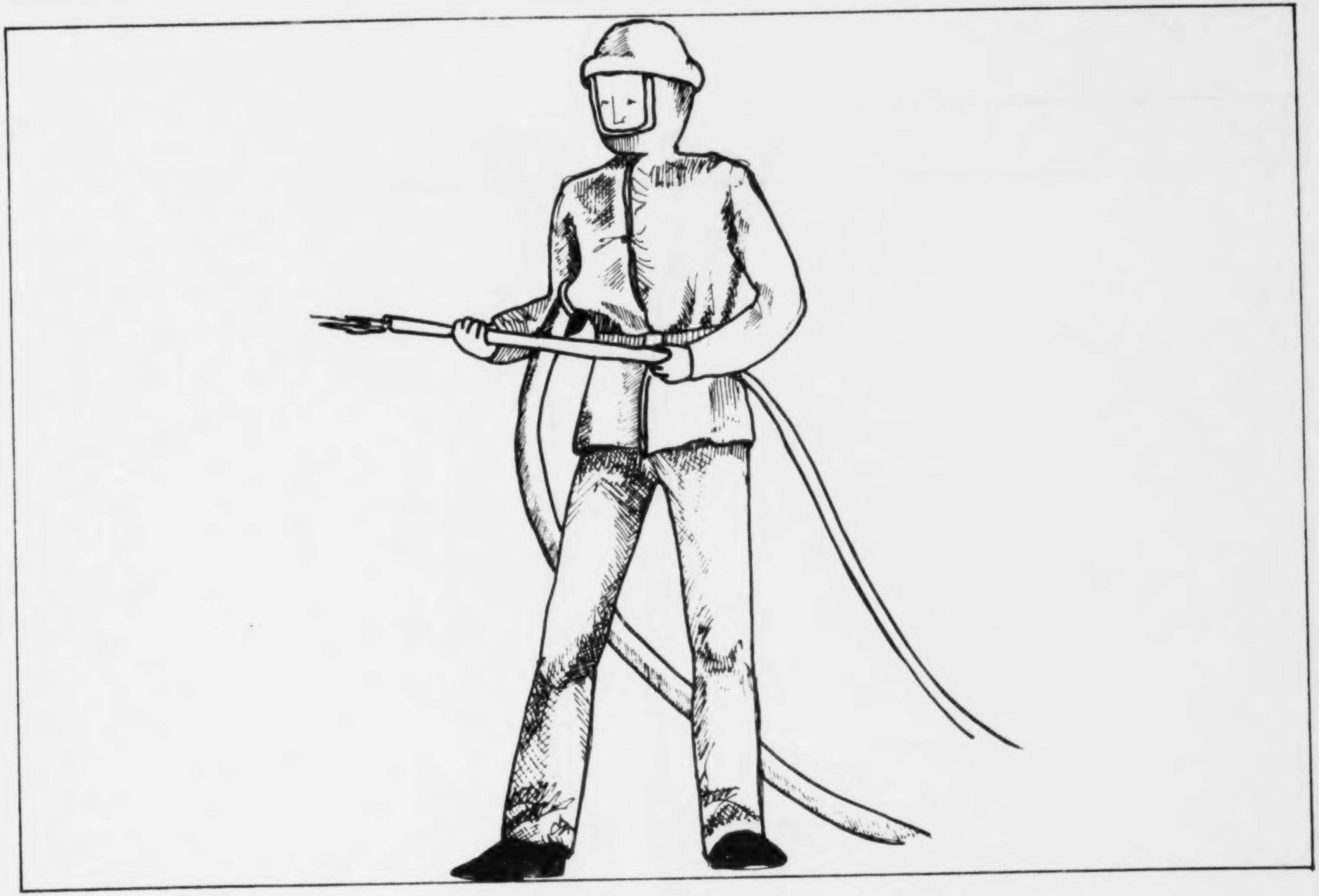
Visual 3

Combustion at the Cell



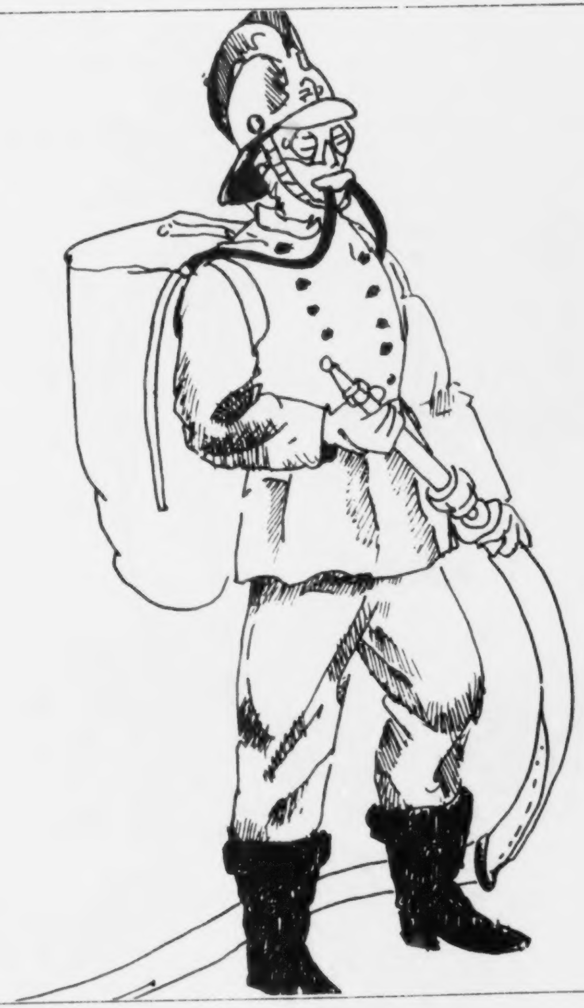
Visual 4

Smoke Filter



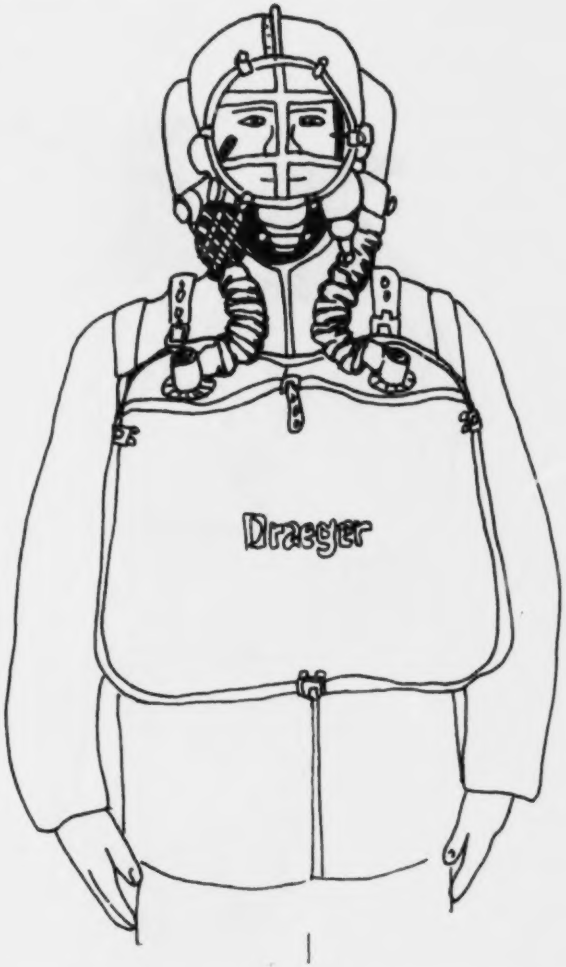
Visual 5

Supplied-Air Suit



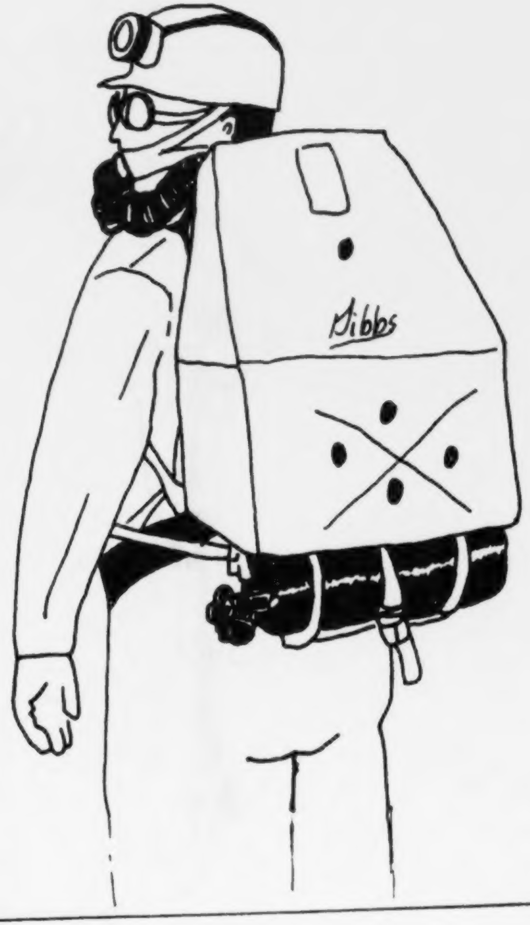
Visual 6

Early Type of SCBA



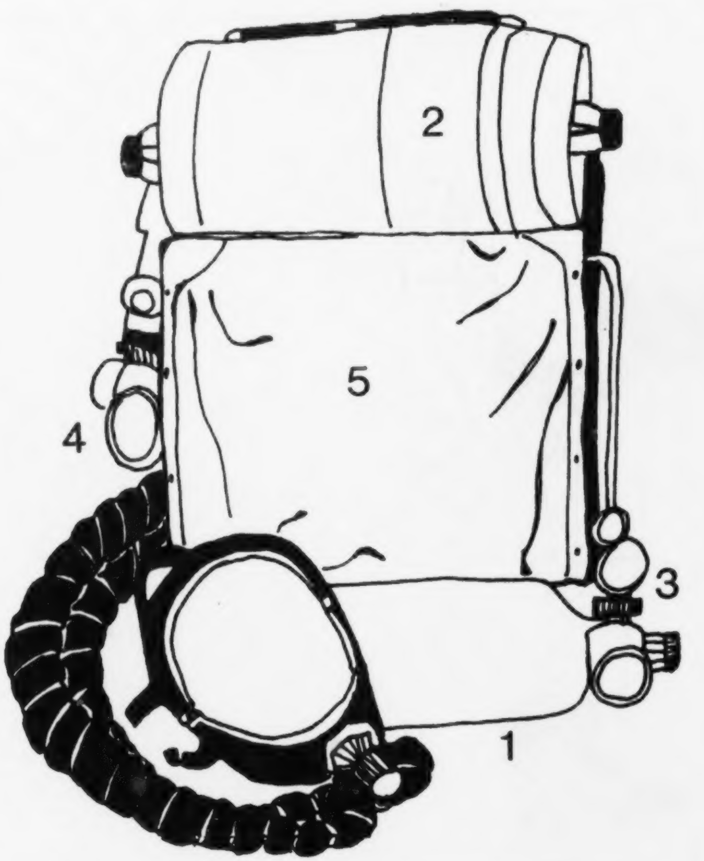
Visual 7

Original Draeger Helmet



Visual 8

Gibbs Apparatus



CLOSED CIRCUIT SYSTEM

Principle Components

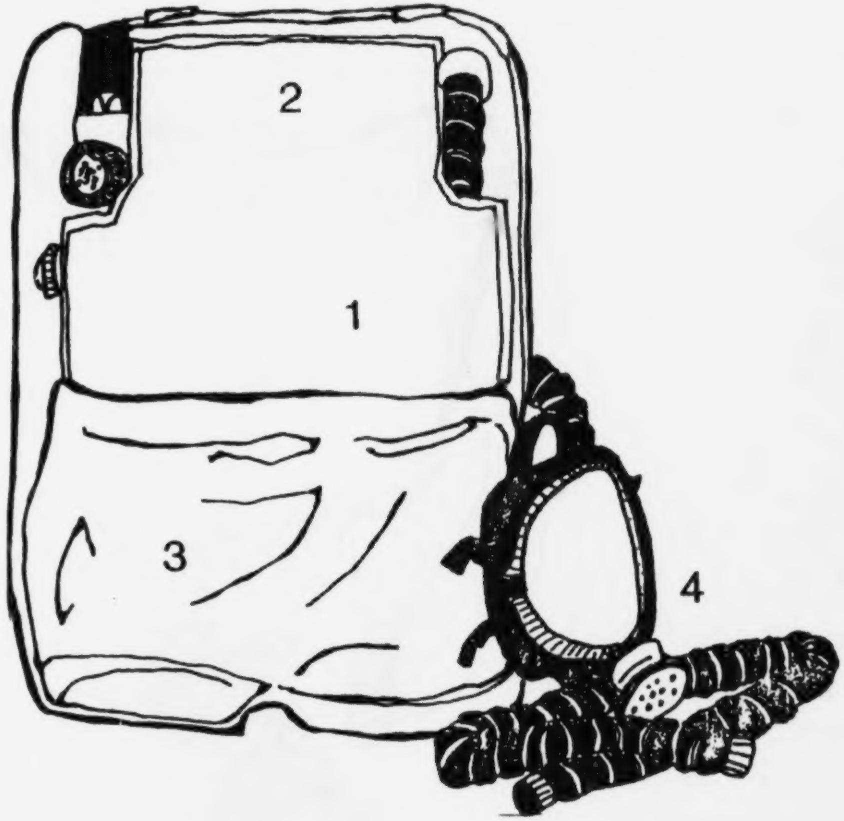
1. Oxygen cylinder
2. Soda lime regenerator
3. Reducing valve
4. Demand valve
5. Breathing bag
6. Facepiece and breathing hoses

Examples

Draeger BG 174; 174-A
McCaa
Scott

Visual 9

Compressed Oxygen Apparatus



CLOSED CIRCUIT SYSTEM

Principle Components

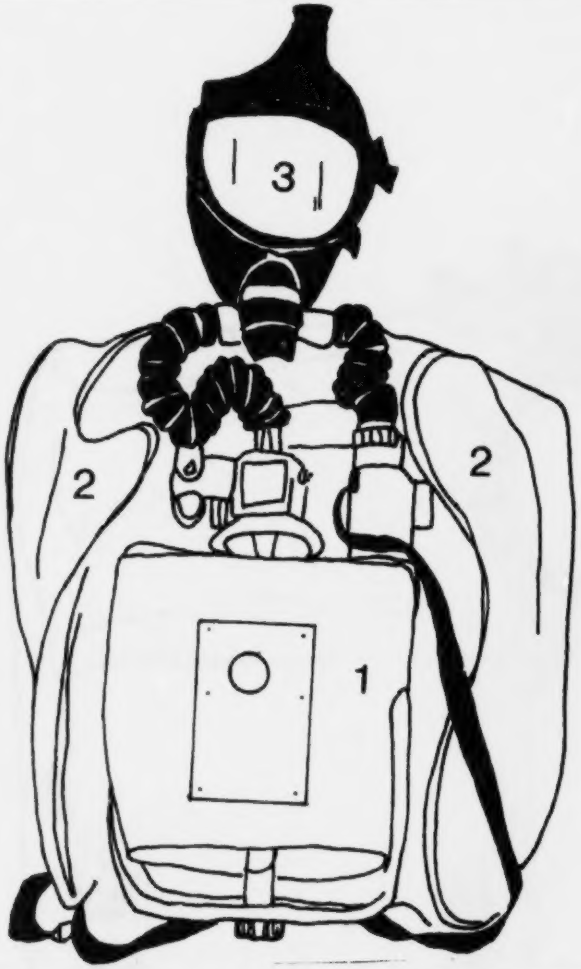
1. Liquid oxygen evaporator
2. Soda lime regenerator to remove CO_2
3. Breathing bag
4. Facepiece and hoses

Example

Aerorlox

Visual 10

Liquid Oxygen Apparatus



CLOSED CIRCUIT SYSTEM

Basic Components

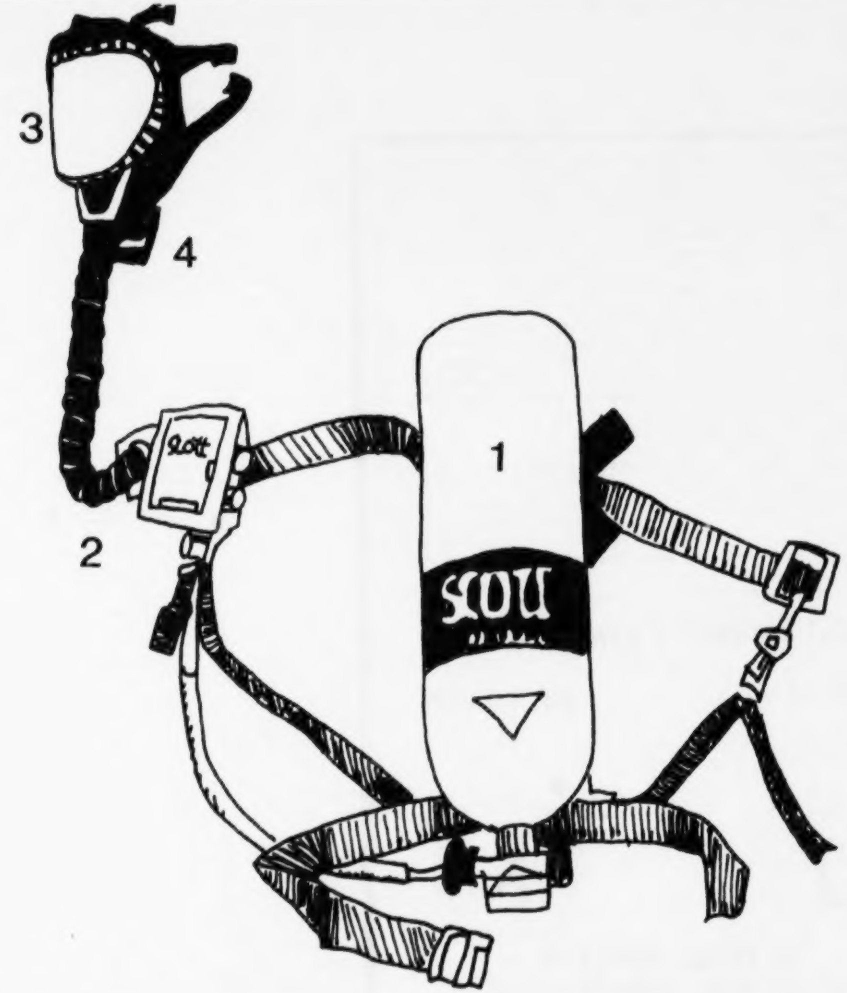
1. Potassium superoxide canister
2. Breathing bag
3. Facepiece and hoses

Example

Chemox

Visual 11

Chemical Apparatus



OPEN CIRCUIT SYSTEM

Basic Components

1. Air cylinder
2. Regulator
3. Facepiece and a breathing hose
4. Exhalation valve

Examples

Scott Air-Pak

MSA Air Mask

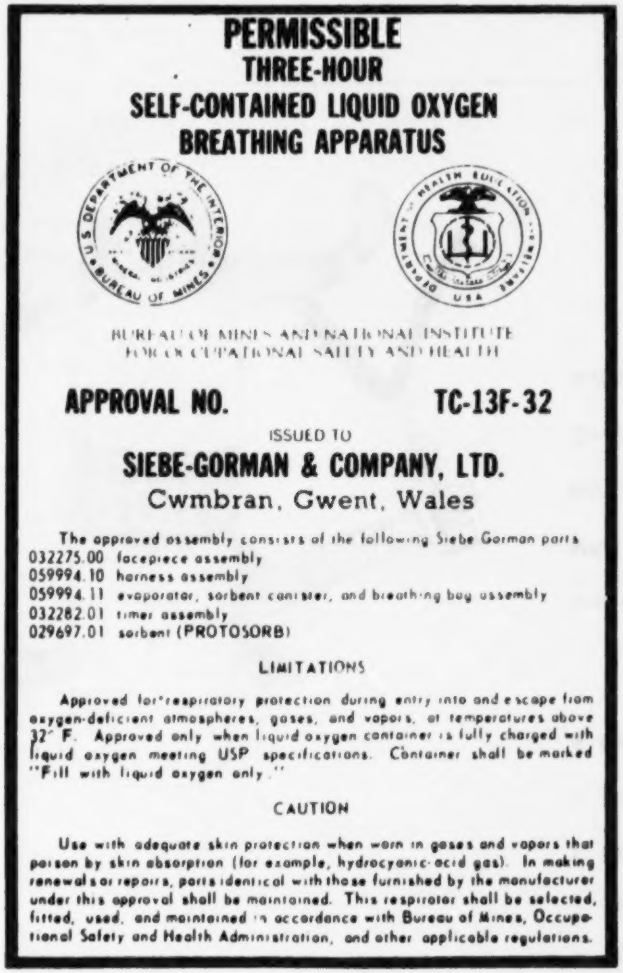
SurvivAir

Globe Guardsman

Siebe Gorman Air Master

Visual 12

Compressed Air Apparatus



PERMISSIBLE
THREE-HOUR
SELF-CONTAINED LIQUID OXYGEN
BREATHING APPARATUS

BUREAU OF MINES AND NATIONAL INSTITUTE
FOR OCCUPATIONAL SAFETY AND HEALTH

APPROVAL NO. **TC-13F-32**

ISSUED TO

SIEBE-GORMAN & COMPANY, LTD.

Cwmbran, Gwent, Wales

The approved assembly consists of the following Siebe Gorman parts

032275.00	facepiece assembly
059994.10	harness assembly
059994.11	evaporator, sorbent canister, and breathing bag assembly
032282.01	timer assembly
029697.01	sorbent (PROTOSORB)

LIMITATIONS

Approved for respiratory protection during entry into and escape from oxygen-deficient atmospheres, gases, and vapors, at temperatures above 32° F. Approved only when liquid oxygen container is fully charged with liquid oxygen meeting USP specifications. Container shall be marked "Fill with liquid oxygen only."

CAUTION

Use with adequate skin protection when worn in gases and vapors that poison by skin absorption (for example, hydrocyanic-acid gas). In making renewals or repairs, parts identical with those furnished by the manufacturer under this approval shall be maintained. This respirator shall be selected, fitted, used, and maintained in accordance with Bureau of Mines, Occupational Safety and Health Administration, and other applicable regulations.

Visual 13

Approval Label

LIMITATIONS OF WEARING SCBA

1. Time Limit, Work Rate, and Breathing Rate
2. Weight and Size of Apparatus
3. Seeing
4. Speaking
5. Facepiece Seal
   a. Beards, Bushy Sideburns
   b. Eyeglasses
6. Specific Limitations of Your Apparatus
   a. Temperature Range for Wearing
   b. Temperature of Breathing Air
   c. Others

Visual 14

Visual 15
Getting Under Oxygen

Note: This is a sample list of procedures for getting under oxygen. It is only provided as a guide. To develop effective steps for your team, you should add the specific steps the team will have to perform for the type of apparatus they are using.

Captain's Commands

1. Team members count off.

   (Team responds No. 1 O.K., No. 2 O.K., etc.)

2. Check that apparatus is properly prepared:

   --Visual check

   – Check CO_2 absorbent

   – Check O_2 supply

   Note: The specific steps in this command will vary depending on the type of apparatus being used. You might add such things as "Check that gauge valve is open."

   (Team responds No. 1 O.K., etc.)

3. Extend straps on harness and facepiece.

   (Team responds No. 1 O.K., etc.)

4. Connect hoses and facepiece to apparatus.

   (Team responds No. 1 O.K., etc.)

5. Mount apparatus and adjust straps.

   (Team responds No. 1 O.K., etc.)

6. Prepare to go under oxygen.

   Note: Depending on the apparatus being used by the team, this command could include "Open cylinder valve."

   (Team responds No. 1 O.K., etc.)

7. Fit facepiece:

   – Check face-to-facepiece seal

   – Check facepiece valves

   (Team responds No. 1 O.K., etc.)

8. **Prepare for team check.**

Captain checks each team member and apparatus, and the co-captain checks the captain.

Note: The specific steps in a team check are covered in the "Wearing Schedule" section included in each of the apparatus modules.

General Review

Introduction to Self-Contained Breathing Apparatus

Directions: Have team members choose the correct answers to the following questions.

1. An approval label gives the following information:

   a. Time limit, cleaning instructions, approval number.
   b. List of approved assembly part numbers.
   c. List of cautions, steps for putting on.
   d. Manufacturer's name, cleaning instructions.
   e. Steps for putting on, time limit.

2. Which of the following are conditions you must get used to in wearing self-contained breathing apparatus:

   a. Voice distortion.
   b. Weight and size of equipment.
   c. Lack of carbon dioxide.
   d. a and b.
   e. b and c.

3. A self-contained breathing apparatus does all the following *except:*

   a. Removes or expels CO_2 from breathing cycle.
   b. Provides oxygen or air.
   c. Protects you from smoke.
   d. Protects you from hydrogen cyanide.
   e. Protects you from carbon monoxide.

4. A closed circuit apparatus differs from an open circuit apparatus because a closed circuit apparatus

   a. Removes oxygen from breathing cycle.
   b. Expels exhaled air.
   c. Has its own source of oxygen.
   d. Recycles breathing air.
   e. Uses chemicals

5. Federal regulations require that breathing apparatus be inspected and tested at least:

   a. Weekly.
   b. Every 15 days.
   c. Every 30 days.
   d. Every 180 days.
   e. Annually.

6. Cleaning and disinfecting the apparatus should be done:

   a. Weekly.
   b. Monthly.
   c. Twice a year.
   d. Before each use.
   e. After each use.

7. A good face-to-facepiece seal is necessary in order that:

   a. The apparatus will start supplying oxygen.
   b. No poisonous gases enter the facepiece.
   c. You maintain negative pressure in the facepiece.
   d. No fog builds up in the facepiece.

8. When getting under oxygen:

   a. The captain will check to see that each person is ready and that each person's apparatus is on correctly.
   b. The co-captain will check that each apparatus is airtight.
   c. You will perform the routine 30-day testing procedures.
   d. You should be sure to check the person to the right of you.

9. Which of the following are normal limitations of wearing an apparatus:

   a. Time restriction.
   b Restriction of peripheral vision.
   c. Should not wear contact lenses.
   d. Should not wear a beard.
   e. All of the above.

10. What is the minimum service time for an apparatus to be classified as a primary apparatus?

a. 30 minutes.

b. 60 minutes.

c. 2 hours.

d. 3 hours.

General review answers:

1. b
2. d
3. d
4. d
5. c
6. e
7. b
8. a
9. e
10. c

Glossary

approval label Label on apparatus showing approval by the government and any specifications for how the apparatus must be used to meet that approval.

auxiliary apparatus Apparatus that provide 30 to 60 minutes' service time.

benchman A person who has responsibility for testing and maintaining the team's apparatus and equipment. A benchman may or may not be a mine rescue team member.

breathing bag Part of the apparatus that contains oxygen-enriched air as a reservoir for breathing.

breathing hoses Hoses that connect the apparatus to the facepiece, allowing air to travel to and from the facepiece.

closed circuit breathing apparatus An apparatus that recirculates exhaled air and makes it safe for rebreathing by removing the carbon dioxide and adding fresh oxygen.

facepiece Part of the apparatus that fits over the face and forms an airtight seal against the outside air.

getting under oxygen A phrase that refers to the process of putting on the apparatus, turning on the oxygen, and making sure the apparatus is functioning properly.

inert gas A gas that doesn't react chemically with other gases; an "inactive" gas.

irrespirable Unfit for breathing.

MSHA Mine Safety and Health Administration.

NIOSH National Institute for Occupational Safety and Health.

open circuit breathing apparatus An apparatus that expels all the wearer's exhaled air (thus the carbon dioxide) and provides fresh air to breathe.

primary apparatus Apparatus that have at least a 2-hour service time.

SCBA Self-contained breathing apparatus.

Schedule 13 Bureau of Mines' former set of standards for testing and approving SCBA.

self-contained breathing apparatus A unit that is worn to supply the wearer with safe air to breathe no matter how bad the surrounding air is. An SCBA has its own supply of oxygen or air and has a means of removing carbon dioxide from exhaled air.

service time The length of time an apparatus is approved to be used per wearing (for example ½, 2, or 4 hours).

soda lime A chemical, which resembles vermiculite, used to absorb or "soak up" carbon dioxide from exhaled air that passes through it.

speaking diaphragm A thin, flexible disc, usually a part of the facepiece, that vibrates (much like a microphone) to allow transmission of the voice to the outside while wearing the facepiece.

team check Check of team members and their apparatus periodically while working under oxygen. Team checks vary according to the type of apparatus being worn.

30 CFR Title 30 of the *Code of Federal Regulations.*

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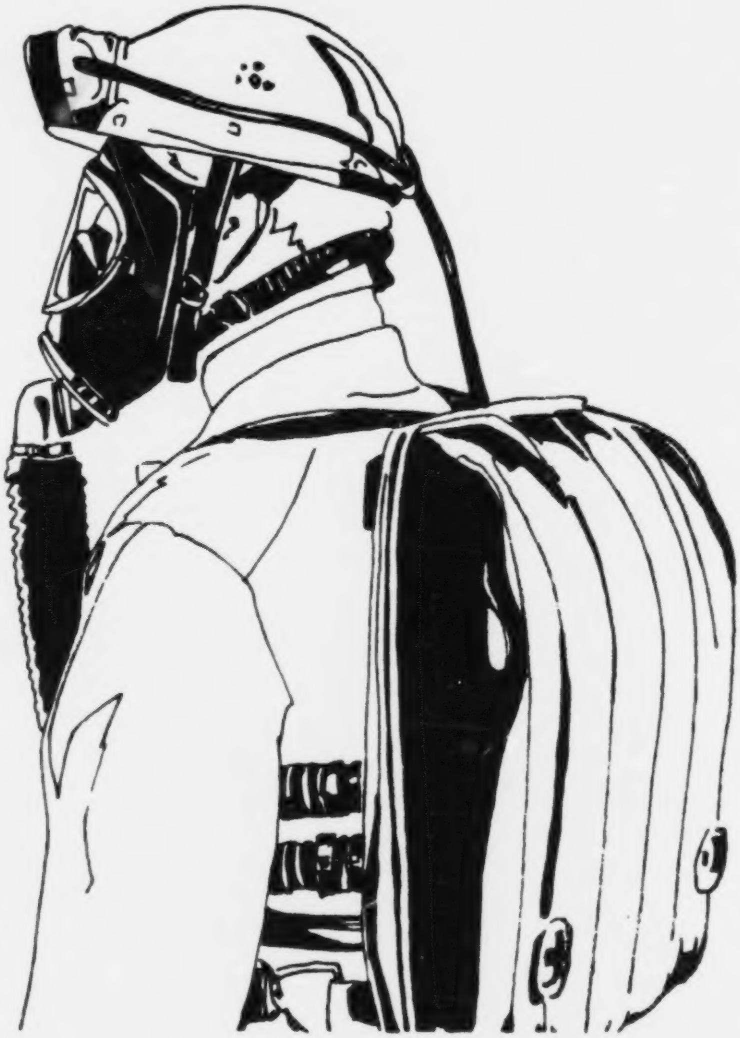
Draeger BG174-A
Self-Contained Breathing Apparatus

Training Module–Initial Mine Rescue

U.S. Department of Labor
Mine Safety and Health Administration
Education and Training Directorate
November 1981

MSHA 2004



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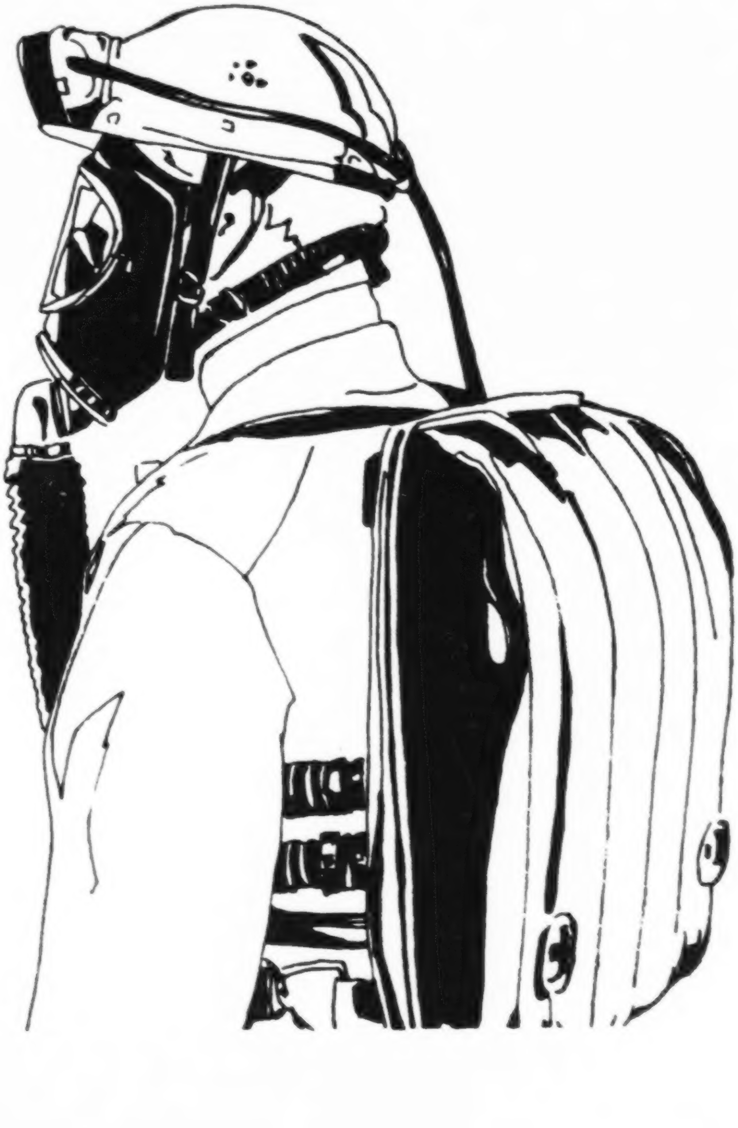

ABOUT THE TRAINING MODULES

The modules are designed to implement the training of the Nation's mine rescue team members as mandated by Part 49, Subchapter H, Chapter I, Title 30, Code of Federal Regulations pursuant to the Federal Mine Safety and Health Act of 1977. Each of the modules covers a separate subject in a self-contained unit with suggested handouts and visual material to aid in its presentation. They are designed specifically for the training of underground inexperienced or experienced mine rescue team members.

Training module MSHA 2001, Instructor's Manual for Mine Rescue Training, contains a list of modules in the training program as well as a glossary that can be useful to the instructor.

This program was developed by the Mining Extension Service of West Virginia University for the Mine Safety and Health Administration under United States Bureau of Mines Contract Number JO308002.

Draeger BG 174-A
Self-Contained Breathing Apparatus

Training Module–Initial Mine Rescue

U.S. Department of Labor
Raymond J. Donovan, Secretary

Mine Safety and Health Administration
November 1981

MSHA 2004

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Course Objectives

Main objective

The mine rescue team member will be able to properly use and maintain the Draeger BG 174-A self-contained breathing apparatus.

Supportive objectives

The team members will:

1. Describe the Draeger BG 174-A and explain what happens in the apparatus during inhalation and exhalation.

2. List the major parts of the Draeger BG 174-A and describe their function.

    a. Protective cover
    b. Wearing harness
    c. Oxygen cylinder
    d. Pressure reducer
    e. Dosage metering orifice
    f. Preflushing unit
    g. Pressure gauge shutoff valve
    h. Manual bypass valve
    i. Pressure gauges
    j. Pressure gauge line
    k. Warning devices
    l. Breathing bag
    m. Lung demand valve
    n. Pressure relief valve
    o. Regenerative canister
    p. Breathing hoses
    q. Facepiece

3. Put on and take off the apparatus correctly and check it for proper functioning.

4. Define the apparatus's limitations when it is worn, and practice wearing the apparatus.

5. Perform required and recommended testing and maintenance of the Draeger BG 174-A.

Course Materials

Required:

- Handouts and visuals from the back of this module
- Pencil and paper for each miner
- Draeger BG 174-A or BG 174
- Draeger Universal Rz25 Tester
- Disinfectant solution for cleaning
- Anti-fog solution for facepiece
- Regenerative canisters (training canister and rescue canister)
- Source of oxygen and cascade system or high pressure oxygen pump

Suggested:

- Overhead projector
- Equipment for making copies and/or transparencies
- Chalkboard

Optional Resources:

- The Draeger manufacturer's information which comes packed with the apparatus

Course Outline

- I. The Draeger BG 174-A
  - A. Description
  - B. Where you wear it
  - C. How it works
- II. Parts of the Draeger BG 174-A
  - A. Cover
  - B. Wearing harness
  - C. Oxygen cylinder
  - D. Oxygen control group
    - 1. Pressure reducer
    - 2. Dosage metering orifice
    - 3. Preflush unit
    - 4. Pressure gauge shutoff valve
    - 5. Bypass valve
  - E. Pressure gauges
    - 1. Chest gauge
    - 2. Cylinder gauge
  - F. Warning whistle (BG 174-A only)
  - G. Breathing bag
  - H. Regenerative canister
    - 1. Refillable, training
    - 2. Factory-packed, rescue
  - I. Lung demand assembly
    - 1. Diaphragm
    - 2. Pressure relief valve
    - 3. Lung demand valve
    - 4. Inhalation and exhalation valves
    - 5. Acoustic reed warning device (BG 174)
    - 6. Dosage metering device (BG 174)
  - J. Facepiece
    - 1. Panorama Nova
    - 2. Scottoramic and Panorama ZS (BG 174)
  - K. Breathing hoses
    - 1. For Panorama Nova facepiece
    - 2. For Scottoramic and Panorama ZS facepieces (BG 174)

III. Putting on the apparatus
  - A. Put on the unit with hoses attached
  - B. Attach hoses to facepiece
  - C. Turn on apparatus (open cylinder valve)
  - D. Put on the facepiece
  - E. Check for airtightness
  - F. Check pressure

IV. Wearing the apparatus
  - A. Manual functions
  - B. Limitations
    1. Weight and size of apparatus
    2. Time limit, work rate, and breathing rate
    3. Temperature range
    4. Others
  - C. Suggested wearing schedule

V. Taking off the apparatus
  - A. Remove facepiece
  - B. Release springhook from saliva trap holding device
  - C. Disconnect breathing hoses from apparatus
  - D. Close cylinder valve
  - E. Take off unit

VI. Bench duties
  - A. Cleaning and disinfecting the apparatus
    1. Removing the exposed parts
    2. Washing, rinsing, and drying
    3. Reassembling the apparatus
  - B. Storing the apparatus
  - C. Oxygen cylinders
    1. Description
    2. Hydrostatic testing
    3. Pressure service rating
    4. Handling and storing
    5. Filling

D. Testing the Draeger
  1. Recordkeeping
    a. Testing records
    b. Maintenance records
    c. Tagging
  2. The Universal Rz25 Tester
    a. Description
    b. Testing the tester
  3. Testing procedure
    a. Visual inspection
    b. Insert oxygen cylinder
    c. Insert regenerative canister
    d. Facepiece and breathing hoses examination
    e. Exhalation valve test
    f. Inhalation valve test
    g. Relief valve test
    h. Positive pressure leak test
    i. Negative pressure leak test
    j. Preflush/pressure gauge equalization test
    k. Lung demand valve/breathing bag volume test
    l. Bypass/constant dosage test
    m. Whistle activation test
    n. Whistle duration/pressure gauge shutoff test
    o. High- and medium-pressure leak test

E. Troubleshooting
  1. Exhalation valve test
  2. Inhalation valve test
  3. Relief valve test
  4. Positive pressure leak test
  5. Negative pressure leak test
  6. Preflush test
  7. Pressure gauge equalization test
  8. Lung demand valve test

9. Breathing bag volume test
10. Bypass test
11. Constant dosage test
12. Whistle activation test
13. Whistle duration/pressure gauge shutoff test
14. High- and medium-pressure leak test

F. Periodic maintenance

Instructor Notes

Note: Throughout this module, the *Visual* notes will recommend that you point out parts on an actual Draeger apparatus. These notes will also refer you to various visuals in the back of the module. You should, if possible, make overhead transparencies of the visuals, sketch them on a chalkboard, or make copies of them to be distributed as handouts to the team members. It is recommended that you use both the actual apparatus *and* the visuals to aid in an overall understanding of the apparatus. However, the use of one or the other will suffice.

Note to instructors training with the Draeger Model BG 174 breathing apparatus: Some earlier Draeger units–Model BG 174–remain in the field. These have a two-hour approval rating, rather than the three-, and four-hour ratings of the BG 174-A's. Some have been converted so that they are approved for three- and four-hour use. (Check approval labels located on the unit's cover for this information.)

Aside from approval durations, the BG 174's differ from their "A" counterparts in only a few aspects. Where they appear in the lecture, these differences will be pointed out to you in accompanying instructor notes labeled *"BG 174 note."* They are also listed for you in the *Appendix* of this training module.

If you're using the BG 174-A apparatus, simply disregard instructor notes and lecture sections that apply to the BG 174.

Suggested Lecture

THE DRAEGER BG 174-A

Objective 1: The team members will describe the Draeger BG 174-A and explain what happens in the apparatus during inhalation and exhalation.

Visual: Display a Draeger BG 174-A so that the team can get acquainted with it as you begin the lecture, and/or refer to "Visual 1" for a picture of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The Draeger BG 174-A (or 174) is a self-contained, closed-circuit breathing apparatus that you carry on your back. For a limited time, it supplies you with fresh oxygen and removes carbon dioxide from the air you breathe.

The Draeger breathing apparatus recycles and replenishes the air in a continuous cycle within the apparatus, completely independent of the air around it.

The BG 174-A weighs about 30 pounds, and its workings are protected by a carrying frame and metal cover. If you encounter conditions such as low roof or an obstructed pathway during rescue and recovery operations, you can remove the Draeger BG 174-A from your back and push it ahead of you or pull it behind you.

The Draeger apparatus is also equipped with automatic and manually-operated safety devices and other features, including pressure gauges to let you know how much oxygen you have.

Once the oxygen cylinder is opened, the unit functions by itself, so aside from checking the pressure gauge now and then, you can concentrate on your work.

Where You Wear It

The fact that the Draeger apparatus is independent of surrounding air makes it particularly well-suited for mine rescue and recovery work after fires and explosions, where you may encounter smoke, toxic or poisonous gases, fumes, or other conditions that make the air around you unfit to breathe.

The apparatus will not offer protection against poisonous gases absorbed through your skin such as hydrocyanic acid.

Because the BG 174-A can provide you with up to 4 hours of breathing protection, the apparatus is especially good for underground work or in other situations where it may be hard to determine exactly how much time you will need in order to complete your work.

BG 174 note: These units are approved for two-hour use.

How It Works

Visual: Trace the flow of air using an apparatus, and/or refer to "Visual 2" for a picture of the airflow pattern in the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Basically, the BG 174-A breathing apparatus works like this: When you inhale, oxygen from the oxygen bottle flows through the breathing bag and travels up the inhalation tube to you. When you breathe out; the exhaled air passes into a regenerative canister where chemicals remove carbon dioxide, a by-product of the breathing process. Then it's passed along to the breathing bag in the middle of the unit where it's mixed with fresh oxygen and the whole process begins again.

The oxygen you use up when you breathe is replaced from an oxygen cylinder at the rate of 1.5 liters per minute. This is known as "constant flow" metering. If you use up oxygen at a faster rate, a lung demand valve built into the apparatus responds by letting more oxygen into the system.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. The Draeger BG 174-A is a "closed-circuit" breathing apparatus. What does that mean?

   (Answer: It means that the BG 174-A recycles and replenishes the air you breathe in a continuous cycle, within the apparatus.)

2. What does the BG 174-A protect you from?

   (Answer: Smoke, certain toxic or poisonous gases, fumes, and oxygen deficiency.)

3. What does the BG 174-A remove from the air you breathe and what does it add?

   (Answer: The chemicals in the canister remove carbon dioxide and the oxygen bottle adds oxygen.)

PARTS OF THE DRAEGER BG 174-A

Objective 2: The team members will list the major parts of the Draeger BG 174-A and describe their function.

1. Protective cover
2. Wearing harness
3. Oxygen cylinder
4. Pressure reducer
5. Dosage metering orifice
6. Preflushing unit
7. Pressure gauge shutoff valve
8. Manual bypass valve
9. Pressure gauges
10. Pressure gauge line
11. Warning devices
12. Breathing bag
13. Lung demand valve
14. Pressure relief valve
15. Regenerative canister
16. Breathing hoses
17. Facepiece

Visual: Point out the following parts on an apparatus, and/or refer again to "Visual 2" for a picture of the main parts of the apparatus.

Use the visual as an overhead transparency, chalkboard sketch, or handout.

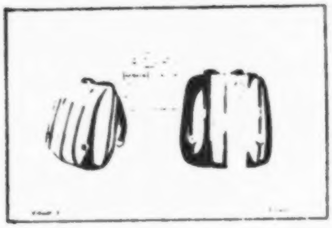
The Draeger apparatus is made up of several parts. These include: the cover, the oxygen cylinder, the oxygen control group, the breathing bag, the warning whistle, the lung demand assembly, the regenerative canister, the breathing hoses and facepiece, the pressure gauges and the pressure gauge line.

BG 174 note: Your model has only one gauge.

Cover

Visual: Point out the cover and approval label on an apparatus, and/or refer to "Visual 3" for a picture of the cover and approval label.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The cover of the Draeger self-contained breathing apparatus acts as a protective shell for its internal parts. It is made of a lightweight yet rugged metal that will withstand heavy wear and tear.

The cover is specially designed to be slim so that it will fit into tight spots. Sled-like ridges on the cover make it easy to slide the apparatus ahead of you or pull it behind you.

Most Draeger units in use have covers made of an aluminum alloy. Newer models have covers made of stainless steel.

The aluminum alloy cover has a stripe of high-visibility orange paint and two strips of reflective tape down the center which make it easy to spot the wearer in darkness, fog, smoke, or other conditions that limit visibility. The stainless steel cover has two red reflectors on the lower part of the cover near the fasteners.

On the top right center of the cover is the approval label. It is here that you will find what the approved service time is for the apparatus, the approval number, and the minimum use temperature.

Note: Point out that the service time also depends to some extent on how hard the team works.

Note: You may discuss other information located on the label, including its joint approval (MSHA and NIOSH); assemblies approved for use with the apparatus; limitations, a note of caution; etc.

Demonstration: Demonstrate opening and closing the apparatus cover as you discuss it.

In order to get at the unit's internal parts, you must first remove the cover. To do this, push in on the step fasteners on the lower part of the cover. When the fasteners release, pull upward and outward on the cover until the tab on top slips out of the slot.

To close it, simply put the top tab into its slot and push the bottom of the cover down over the fasteners until you hear it "snap" into place.

Wearing Harness

Visual: Point out the wearing harness on an apparatus and/or refer again to "Visual 1" for a picture of the wearing harness.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Demonstration: Demonstrate how to fasten and adjust the harness straps as you discuss it below. (The team members will learn how to put on the apparatus later on in the lecture.)

The wearing harness consists of two adjustable shoulder straps with double slide buckles and a waist belt.

The shoulder straps have plastic rings on the ends that, when pulled down, adjust the straps for proper fit.

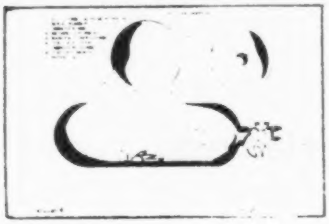
The double slide buckles are designed for quick release.

The right shoulder strap is equipped with a tension reliever strap. There is a springhook on this strap which clips to the breathing hoses to relieve some of the hoses' weight from your facepiece.

Oxygen Cylinder

Visual: Remove the oxygen cylinder and point out the various markings and parts on the cylinder, and/or refer to "Visual 4" for a picture of the cylinder.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Once the cover is removed, you can easily see the unit's oxygen cylinder, which is fitted horizontally to the bottom of the frame.

Note: The oxygen cylinder is sometimes referred to as the oxygen "bottle."

Note: Always put the cover nut on the main cylinder valve connector when it's disconnected from the unit. Be sure the team does this, too. The cover nut, which is included with the unit's tool kit, helps keep moisture and dirt out of the unit.

The BG 174-A's cylinder is made of strong alloyed steel. It has a capacity of 2 liters, which is roughly equivalent to 2 quarts. At full pressure the cylinder can contain up to 440 liters of compressed oxygen.

Note: Fully charged, the cylinder on a 2-hour approved apparatus has 1800 pounds per square inch (PSI) oxygen; a 3-hour approved apparatus has 2600 PSI oxygen; and a 4-hour approved apparatus has 3135 PSI oxygen.

The cylinder must be tested every 5 years to see that it remains in good condition. We will be discussing more about this testing procedure later on when we go over the care and maintenance of the Draeger.

Note: The testing procedure described above is "hydrostatic testing" and will be explained in the "oxygen cylinder" section of "Bench Duties."

Just opposite the connection that joins the cylinder to the unit is the cylinder valve which is used to open and close the cylinder. This valve has a special "slip clutch" design which helps keep you from opening or closing it accidentally.

Demonstration: Show how this is done on the apparatus as you describe the procedure.

To open the cylinder valve, pull out on it and with two fingers, gently turn it counterclockwise until it's all the way open, then turn it back about a half turn. Turning it back half a turn leaves some "play" in the valve so that when you're wearing the apparatus you can reach back and assure yourself that the valve is open.

When you close the valve, again pull it out and with two fingers only, turn it clockwise until the valve is closed.

The "two-finger" method is recommended because twisting the valve too hard can strip or otherwise damage the threads on the valve seat's spindle.

On the top of your oxygen cylinder is a safety device known as the pressure burst cap.

Note: Tell the team the pressure burst cap is also referred to as the "pressure burst disc."

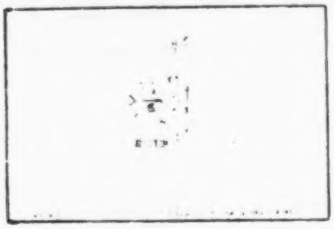
When the pressure within the cylinder reaches 4450 PSI, the cap will "burst," allowing oxygen to escape through holes in it. This keeps the bottle from rupturing with great force. Heat can cause the cylinder to approach the 4450 PSI "danger limit."

At 2000 PSI, it takes approximately 700° F to make the oxygen within the cylinder expand to 4450 PSI, causing the cap to burst. With a full, four-hour cylinder–3135 PSI–it takes approximately 300° F to do the same thing.

Oxygen Control Group

Visual: Point out the oxygen control group and its parts on an apparatus, and/or refer to "Visual 5" for a picture of the oxygen control group.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Also, refer again to "Visual 2" to show where the oxygen control group is in relation to the other parts of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

On the right side of the unit's carrying frame are a number of parts which together make up the oxygen control group. These are the parts that control (or regulate) the oxygen supply as it comes from the cylinder.

Note: Mention that this group of parts is also referred to as the "regulator assembly."

The oxygen control group is connected to the oxygen cylinder by a threaded, finger-tight connection, and to the breathing system by way of the preflush/dosage line.

Parts included in the oxygen control group are: the pressure reducer, the dosage metering orifice, the preflush unit, the pressure gauge shutoff valve, and the bypass valve.

Pressure Reducer

The pressure reducer is located in the center of the oxygen control group.

The adjustment nut for the pressure reducer is located inside the sealed blue knob-like housing you'll see in the oxygen control group. As its name indicates, this part reduces the pressure of oxygen coming from your cylinder to a more manageable 57 PSI.

Note: The lead seal on the blue housing should only be removed by the manufacturer.

Dosage Metering Orifice

This oxygen then flows through the dosage metering orifice, a drilled orifice (hole) which meters it to deliver a "constant flow" of about 1.4 to 1.7 liters per minute to the breathing bag. This is enough oxygen to sustain you while you're working at a moderate rate. By contrast, while you're sitting in this room, you use up about eight-tenths (.8) liters per minute.

Note: Tell the team members that "liters per minute" is often referred to as LPM.

Preflush Unit

Within the housing with a black rubber cover are parts designed to flush the breathing bag with 6 to 7 liters of pure oxygen immediately after the cylinder is opened. The parts within this housing are known as the preflushing unit.

Automatically preflushing the breathing bag serves two purposes: It gets rid of any residual air that might have accumulated in the bag, and it makes the apparatus immediately ready for use in an emergency.

Note: Normal breathing air is 78 percent nitrogen. Nitrogen is a gas in air that is not eliminated from the Draeger's system (as is CO_2) during the breathing process. Although it is not poisonous, nitrogen can build up in the breathing bag to the extent that it dilutes the otherwise purified oxygen within it.

Pressure Gauge Shutoff Valve

The parts of the oxygen control group that we'll be talking about next–the pressure gauge shutoff valve and the manual bypass valve–are very important ones. Hopefully, you'll never have to use them. These are "back up" safety devices designed to be used in an emergency.

The pressure gauge shutoff valve is the metal lever located between the pressure reducer and the preflush unit. You should close this valve only if you suspect your pressure gauge or pressure gauge line is leaking. (This is usually indicated by a sharp, quick drop in your chest gauge reading or the premature sounding of the warning whistle.)

To activate the pressure gauge shutoff valve, lift the lever approximately 30 to 45 degrees from the horizontal to the stopping point. Lifting the lever shuts off oxygen from your pressure gauge line and warning whistle. It does not affect the constant dosage or the medium-pressure oxygen going to your lung demand valve.

Note: You may wish to point out that the "warning whistle" is a device that warns the wearer when oxygen pressure is down to 20 to 25 percent of charged pressure.

Once you've lifted the lever, keep an eye on your chest gauge so you can tell if there's a leak in the gauge or gauge line. If there is a leak, oxygen trapped in the line will escape, making the pressure gauge reading fall quickly, and when the pressure reaches 20 to 25 percent of full cylinder pressure, your warning whistle will sound for 20 to 60 seconds.

These two factors–complete loss of gauge line pressure and the brief sounding of the warning whistle–prove that there is a leak, the pressure gauge line is severed, or the gauge is malfunctioning, so leave the shutoff lever in the "up" position.

However, if your pressure gauge reading does not drop and gas trapped in the line keeps the gauge "frozen" at the pressure you read when you first lifted the shutoff lever–you'll know there is no leak in the pressure gauge line. If that's the case, be sure and put the shutoff lever back down in its original position.

This is important for two reasons: (1) If you don't push the lever back down, your chest gauge will continue to indicate how much pressure you had when you lifted the shutoff lever rather than what's actually in the cylinder. (2) If your pressure gauge shutoff lever is in the "up" position your warning whistle is isolated, so it cannot sound to let you know when your oxygen is low.

Bypass Valve

The second of the two safety features located within the oxygen control group is a black recessed button surrounded by a red rim–the manual bypass.

BG 174 note: The manual bypass is not trimmed with red on these models.

Like the pressure gauge shutoff valve, the manual bypass is for emergency use only.

It is called a "bypass" valve because pushing it sends oxygen directly from the cylinder to you, hence "bypassing" the parts of the apparatus that limit or control its pressure.

Note: Due to the orifice size of the bypass line and the fact that the oxygen is entering the large low pressure cavity in the apparatus, the pressure of the oxygen entering the unit is not actually at cylinder pressure.

Use this bypass valve only if your oxygen control malfunctions and you're not getting the required 1.5 liters of oxygen per minute. To activate the bypass valve, you need only press it for an instant and then release it. The valve is self-closing.

Because it bypasses elements within the system that control oxygen supply, this valve can deliver up to 50 liters of oxygen per minute to the breathing bag. That's far more than you need so use it sparingly.

You should also keep in mind that since the oxygen is coming directly to you from the cylinder, you'll use up what's in your cylinder much faster. That means you'll have far less time under oxygen.

Never use the bypass valve to "freshen" or "cool" the oxygen in the breathing bag. That's simply a waste of oxygen.

Remember to use the manual bypass only when it is absolutely necessary -and when you do, use it sparingly.

Pressure Gauges

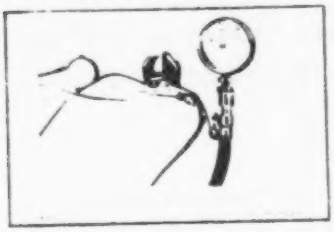
BG 174 note: Many of these models have only one pressure gauge--the chest gauge. Leave out parts of the lecture that refer to the cylinder gauge if your units don't have it.

A pressure gauge is an instrument which measures the amount/pressure of oxygen in your cylinder. The BG 174-A has two of them—a chest gauge and a cylinder gauge. They are marked in increments of 200 PSI and are luminous so you can see them in the dark, or in other conditions that limit visibility.

These two gauges, though they both give the oxygen pressure reading, work independently of each other.

Visual: Point out the chest pressure gauge on an apparatus, and/or refer to "Visual 6" for a picture of the chest pressure gauge.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Chest Gauge

The chest pressure gauge operates only when the oxygen valve is open. It measures the oxygen pressure going into the apparatus from the cylinder. This gauge is located at the end of the high-pressure line extending from the oxygen control assembly and warning whistle.

The chest gauge is the one you'll refer to when you're actually wearing your Draeger apparatus. It is fastened to the right side of the harness by a rubber strap so it's always within easy reach. When not in use, the chest gauge is protected by a metal cover.

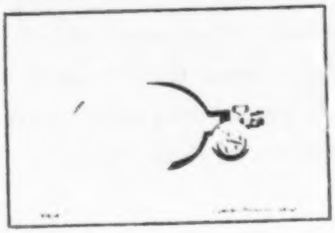
After checking the pressure, the gauge should always be put back into its cover. This holds the gauge and protects it from external damage.

Leading from the unit to the chest gauge is a rubber-coated pressure gauge line. Inside the tube's rubber coating is a closely wound spiral high-tension line which is relieved of tension by a bronze core. Remember that if this tube develops a leak, you can lift the pressure gauge shutoff lever to keep oxygen from flowing into it.

Demonstration: Refer back to the pressure gauge shutoff lever in the oxygen control group. Show the team members how it is used.

Visual: Point out the cylinder pressure gauge on the oxygen cylinder, and/or refer to "Visual 7" for a picture of the cylinder pressure gauge.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Cylinder Gauge

The cylinder pressure gauge is attached to the top of the oxygen cylinder. It gives a constant reading of the pressure, whether the cylinder is in storage or in the apparatus. This is the gauge you'll refer to when you fill your cylinger or add a new one. When the unit is in use, the cylinder gauge is not visible because it is under the unit's cover.

Note: Many BG 174-A's now in use have red hash marks at 2850 PSI. This may cause some confusion, but just explain that the 2850 is the *European* 4-hour approval rating. Newer models of the Draeger apparatus will have red hash marks where they belong, with reference to the Unit's U.S. 4-hour approval rating–at 3135 PSI.

Warning Whistle

BG 174 note: This model's acoustic reed type warning device is located on the left-hand side of the apparatus. You will discuss it later when you talk about the lung demand assembly.

If you are using the BG 174 units, simply omit the following "warning whistle" section and continue with the lecture.

Visual: Point out the warning whistle on an apparatus, and/or refer again to "Visual 2" to show where the warning whistle is on the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Connected to the pressure gauge line assembly above the oxygen control group is a whistle called the warning whistle. It is designed to warn you when you have only 20 to 25 percent of the original charged pressure left in your cylinder.

It will also alert you to a leak in the high-pressure line leading to the chest gauge. When the pressure reaches the point where the whistle sounds, the leak can be stopped by lifting the pressure gauge shutoff lever.

Note: The "warning whistle" is sometimes referred to as the "retreat warning device."

Note: Because the warning whistle is tied in with the pressure gauge line, it will not activate when the pressure gauge shutoff valve is closed.

When the warning whistle sounds, it blows for about 20 to 60 seconds and uses about 3 liters of oxygen.

When you hear this whistle, you'll know you have approximately 90 liters of oxygen remaining – or about 45 to 60 minutes' worth of oxygen.

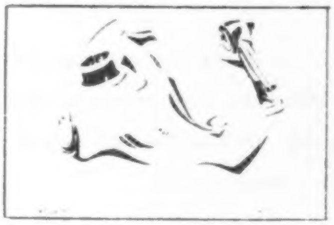
The whistle will sound at about 700 PSI on a 4-hour apparatus, and at 600 PSI on a 3-hour apparatus.

Demonstration: To get the warning whistle to sound, lift the *pressure gauge shutoff lever* and, with two fingers, open the *oxygen cylinder valve*. The whistle should sound for 20 to 60 seconds.

Breathing Bag

Visual: Point out the breathing bag on an apparatus, and/or refer to "Visual 8" for a picture of the breathing bag.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



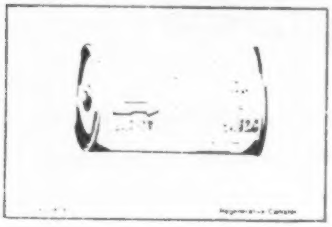
The breathing bag is located at the center of the unit, protected on all sides by the carrying frame. It is made of a synthetic 3-ply rubber fabric and has a volume of 5 to 7 liters.

The breathing bag has two "sockets" on it. One of these is a threaded socket which connects to the lung demand assembly, and the other elbow socket connects to the regenerative canister. By unscrewing these sockets and the preflush/dosage line, you can remove the breathing bag for cleaning and disinfecting.

Regenerative Canister

Visual: Point out the canister and its markings on an apparatus, and/or refer to "Visual 9" for a picture of a canister.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The metal unit at the top of the apparatus is called the regenerative canister.

The special chemicals inside the regenerative canister absorb the carbon dioxide from the air that is exhaled by the wearer. The oxygen in the exhaled air is not affected by the chemicals. It passes through the canister and goes back into the breathing bag where it can be breathed again.

Note: The maximum allowable CO_2 in the breathing bag during MSHA/NIOSH testing is 0.5 percent.

There are two types of canisters you can use with the Draeger apparatus:

1. Refillable training canister
2. Factory-packed, disposable canister (sometimes referred to as an alkali canister).

The basic difference between the two is that the factory-packed, disposable canister is the only one approved for actual rescue work.

Both canisters have arrows on them that match up to the arrows on the canister holder at the top of the apparatus.

Refillable Training Canister

The refillable training canister is approved for training purposes only and has a maximum period of 4-hours use. It is made of stainless steel and can be used over and over again as long as the absorbent chemicals are freshly packed for each use.

Inside the canister is a set of baffles designed to expose more surface area of the chemicals to the exhaled air. The canister must be completely filled each time it is used in order to get good results. You will learn the proper procedure for filling the canister later on in the lecture.

The chemicals used to fill the canister have a shelf-life of approximately 2 years from the date of manufacture which is printed on the packaging label. For easy reference, the expiration date for the chemical is also printed on the label.

Note: Some of the absorbent chemicals are made with what is called "violet indicator" in them, and they turn from white to violet in color when the chemical no longer has the ability to absorb carbon dioxide. *Therefore, chemicals that have turned violet in color should not be used to fill a canister.*

Factory–Packed Rescue Canister

The factory-packed, disposable rescue canister is the only canister approved by MSHA and NIOSH for actual rescue work. It can be approved for up to 4-hours use. It provides drier and cooler (approximately 20° F cooler) breathing air. It also is a more reliable canister because it is packed to meet certain specifications and is sealed at the factory.

The factory-packed rescue canister has an approval label and a factory label with information such as weight, the expiration date, and the approved time period the canister will absorb the carbon dioxide (that is, two, three, or four hours). This information should be checked before using the canister.

Note: The factory-packed canister has a shelf life of about four years from the date of manufacture.

The canister also has a string seal running from the inlet to the outlet of the canister. This seal indicates that the canister is still factory-sealed. Do not break this seal until you are ready to use the apparatus.

If the canister has expired, yet is still factory-sealed, it can be used for training provided that the chemicals can be heard rattling around when the canister is shaken and the canister has not gained 10 or more grams in weight. If the chemicals are caked up, the carbon dioxide will not be absorbed from the exhaled air. Do not, under any circumstances, reuse a factory-packed canister. Throw it away after using it.

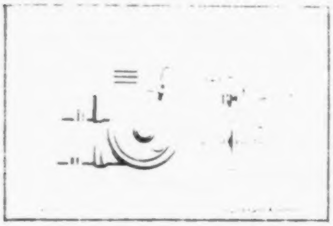
Lung Demand Assembly

Note: The lung demand assembly is sometimes referred to in the field as "demand regulator assembly," "valve group," or "valve assembly."

Visual: Point out the lung demand assembly on an apparatus, and/or refer to "Visual 10" for a picture of the lung demand assembly.

Also, refer again to "Visual 2" to show where the lung demand assembly is in relation to the other parts of the apparatus.

Use these visuals as overhead transparencies, chalkboard sketches, or handouts.



The lung demand assembly controls the delivery of breathing air from the apparatus to the wearer. It is called a demand assembly because it responds according to what your lungs "demand."

The lung demand assembly contains the:

1. Diaphragm
2. Pressure relief valve
3. Lung demand valve, and
4. Inhalation and exhalation valves.

BG 174 note: The BG 174 lung demand assembly also contains the:

1. Acoustic reed warning device, and
2. Dosage metering device.

The two parts of the lung demand assembly we'll be talking about next–the pressure relief valve and the lung demand valve–operate according to your consumption of the 1.4 to 1.7 liters of oxygen per minute supplied by the unit's constant flow metering device.

Diaphragm

These parts depend for their operation on a very important part of the lung demand assembly–the diaphragm. This is how it works:

Demonstration: Take the diaphragm assembly out of the apparatus, and then disassemble the diaphragm assembly. During the following lecture section, show how the diaphragm moves in and out, and how the relief and demand valves work.

This diaphragm moves in or out in response to pressure created by the breathing bag.

When the breathing bag has too much oxygen in it, it becomes overinflated and so produces a forward pushing pressure or "positive pressure" against the diaphragm.

On the other hand, when the bag has less than the normal amount of oxygen in it, it becomes deflated, pulling the diaphragm in toward it. This pulling motion is known as "negative pressure."

Pressure Relief Valve

Visual: Point out the pressure relief valve in the lung demand assembly, and/or refer again to "Visual 10" for a picture of the pressure relief valve.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The pressure relief valve is the part of the lung demand assembly that keeps oxygen from building up in the breathing bag if you use less than the unit provides.

For example, if you're resting, you probably won't consume as much as 1.4 to 1.7 liters per minute of oxygen. The excess oxygen will then fill the breathing bag to the point where it becomes overinflated. The overinflated bag creates positive pressure which pushes against the diaphragm, causing it to move outward against a spring.

As the diaphragm moves outward, it moves away from the sealing bolt, revealing an opening in the diaphragm that normally remains closed. The excess air flows through this opening, escaping to the outside atmosphere through a nonreturn valve.

Lung Demand Valve

Visual: Point out the lung demand valve in the lung demand assembly, and/or refer again to "Visual 10" for a picture of the lung demand valve.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The lung demand valve is the part of the lung demand assembly that automatically lets more oxygen into the circuit if you require more than what's flowing into the breathing bag.

If you are working hard, for example, the amount of oxygen you need may be greater than the 1.4 to 1.7 liters per minute your unit normally supplies. When this happens, the breathing bag deflates with each breath you take until it no longer supplies you with enough oxygen. This is where the lung demand valve comes in.

As the bag deflates, negative pressure pulls on the diaphragm. This forces the plunger in the diaphragm to move inward against the valve's stickpin-type lever. The lever in turn opens the valve, allowing oxygen (at 57 PSI) to flow directly from the pressure reducer to the lung demand assembly by way of the medium-pressure oxygen line. This oxygen flows into the circuit at a rate of 80 to 120 LPM.

Visual: Point out the oxygen line on an apparatus, and/or refer again to "Visual 2" to show where the medium-pressure oxygen line is in relation to the other parts of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Inhalation and Exhalation Valves

In a closed-circuit breathing apparatus, keep in mind that it is very important that the breathing air flows only in one direction. If it didn't, you'd risk breathing in exhaled air filled with carbon dioxide, or fresh oxygen might not get to you. In the Draeger apparatus, the inhalation and exhalation valves keep the air flowing in one direction.

Visual: Refer again to "Visual 2" to show where the inhalation and exhalation valves are located in the apparatus.

Use the visual as an overhead transparency, chalkboard sketch, or handout.

During inhalation the air is drawn out of the breathing bag through the lung demand assembly. The air then passes through the inhalation valve near the bottom left side of the lung demand assembly.

When the air is exhaled by the wearer, it passes through the exhalation valve located on the top of the lung demand assembly.

Remember, these are one-way valves designed to control the direction of air flow in the breathing system.

BG 174 note: Include the following as part of your lecture on the lung demand assembly of the BG 174.

Acoustic reed warning device: On the BG 174, a control bellows inside the lung demand assembly controls the movements of the warning signal flap. If the oxygen cylinder pressure is depleted, or if the cylinder valve is off, the bellows expand causing the flap to close between the lung demand assembly and the breathing bag. The audible reed located in the flap then produce a warning note.

Dosage metering device (drilled orifice): The BG 174's dosage metering orifice is located in the lung demand assembly rather than in the oxygen control group as it is on the BG 174-A. This drilled orifice provides a constant flow of oxygen at the rate of 1.5 LPM. The orifice is at the end of a separate oxygen supply line coming from the pressure reducer.

Facepiece

Note: The Panorama Nova facepiece is the only facepiece approved for use with the BG 174-A. There are four models of the Nova facepiece:

1. Nova Z (without wiper)
2. Nova ZS (with wiper)
3. Nova ZST (with wiper and communication equipment)
4. Nova ZT (with communication equipment but without wiper).

Omit the following sections of the lecture which do not deal with the facepiece model the team will be using.

BG 174 note: The Scottoramic facepiece may have been supplied with the BG 174 apparatus. The Scottoramic facepiece, the Draeger Panorama ZS, and the Panorama Nova facepieces are approved for use with the BG 174.

If the team will be using the Scottoramic or Panorama ZS facepiece, omit the following lecture section, and turn to the next BG 174 note, where these facepieces will be explained.

Visual: Point out the various parts discussed in this section on an apparatus facepiece, and/or refer to "Visual 11" for a picture of the facepiece used with your apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The Panorama Nova is the facepiece used with the BG 174-A. It has a single "panorama" type lens which offers 90 percent peripheral vision, allowing you to see most of what you normally see. It permits unobstructed vision with both eyes, which is very important in judging distances.

The mask has a double-sealing edge for protection against the infiltration of smoke and gases. The Nova facepiece also has a nosecup inside the mask designed to help channel the inhaled and exhaled air to and from the wearer. This nosecup acts as the third sealing edge to protect you from smoke and gases.

The Nova facepiece has a five-strap head harness, which adjusts to provide a good facepiece seal, and a neck strap which you can put around your neck to support the mask when you are not wearing it. The neck strap can be shortened from its regular length so you can carry the facepiece close to your chest when you are not under oxygen. It is shortened by attaching the button which is located on the strap, to the small buttonhole on the center head strap.

Nova Z and ZT note: Special frames for prescription eyeglasses are available for use with the Nova Z and ZT facepieces. These frames *cannot* be used with the wiper lenses in the Nova ZS and ZST facepieces.

Nova Z and ZS note: The Nova Z and ZS have speaking diaphragms in them. When you speak with the facepiece on, the speaking diaphragm, which is made of aluminized mylar, allows transmission of your voice.

Nova ZST and ZT note: The Nova ZST and ZT have telephone equipment built into the facepiece as well as a speaking diaphragm.

Nova ZS and ZST note: The Nova ZS and ZST facepieces are equipped with a visor wiper. This manually operated wiper is made of leather and must be kept lubricated with antifog solution at all times, including storage, in order to keep the leather from drying out.

To operate the wiper correctly, turn one of the wiper knobs to bring the wiper from the top of the lens and then turn the other wiper knob. Reverse that procedure to bring the wiper to the top rest position. This will give you a good clean sweep of the inside lens. Newer Nova ZS and ZST facepieces may be equipped with a central wiper similar to a car windshield wiper. This type of wiper was previously used on the Panorama ZS facepiece.

Note: Anytime the lens, speaking diaphragm, speaking diaphragm "O" ring, wiper mechanism, or gaskets and "O" rings are changed or replaced, the reassembled facepiece must be tested for leaks. This can be done with the Draeger mask tightness tester.

At the lower part of the facepiece is a single coupling assembly where the breathing hoses are attached. You will notice, when you look closely at the facepiece connection, that it has a divider or ridge built into it. This divider helps to separate the inhaled air from the exhaled air as it passes between the hoses and the wearer.

Breathing Hoses

Visual: Point out the breathing hoses used on an apparatus, and/or refer again to "Visual 2" to show the breathing hoses in relation to the other parts of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The breathing hoses used with the Panorama Nova facepiece are made of durable, corrugated rubber. They are very flexible and offer little resistance to inhaled and exhaled air, enabling you to breathe almost as freely as in open air.

The hoses consist of an inhalation hose and an exhalation hose. The inhalation hose has a saliva trap attached to it. The trap is on the inhalation hose because it must be located on the lowest part of the apparatus when it is worn so that the moisture will settle there. The trap features a chain connection between the trap and its cap, so that the cap cannot be misplaced when it is removed.

The hoses, like the facepiece, have a single coupling assembly (for attachment to the facepiece) with a divider to channel the breathing air. There is also a small dam inside to prevent excess saliva from going into the exhalation hose.

At the other end of the hoses are two threaded connections for attachment to the apparatus. The inhalation hose (with the saliva trap) connects to the inhalation hose connection at the lower portion of the lung demand assembly. The exhalation hose connects to the exhalation hose connection near the top of the lung demand assembly.

BG 174 note: The Scottoramic facepiece approved for use with the Draeger apparatus has a six-strap head harness and has two threaded fittings to accept the breathing hoses. The lower of the two fittings is the inhalation hose connection, and the topmost fitting is for the exhalation hose.

The inhalation hose has a saliva trap attached to it.

The breathing hoses used with the Scottoramic facepiece have two threaded fittings at one end for connection to the facepiece. At the other end are the threaded fittings for connection to the apparatus.

The inhalation hose (with the saliva trap) connects to the apparatus at the inhalation valve coupling near the bottom of the lung demand assembly; and the exhalation hose connects to the exhalation valve coupling near the top of the lung demand assembly.

The Panorama ZS facepiece with a central hose connection is an earlier version of the Panorama Nova facepiece. The lens is differently shaped and has a single wiper in the center of the mask. This wiper is similar to a car windshield wiper.

Review questions Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. Where do you find the duration of use data for a BG 174-A?

   (Answer: On the approval label located on the cover.)

2. Before you fill the oxygen cylinder, what two things should you check and why? (Answer: The hydrostatic test date and the pressure service rating, both stamped on the cylinder. The cylinder must be tested at least every five years by a certified testing facility. The pressure service rating must be checked to see how much oxygen the cylinder can safely hold.)

3. How do you open the cylinder valve?

   (Answer: Pull out on the valve and gently turn it counterclockwise until it is all the way open. Then turn it back about a half turn. Use only two fingers for this.)

4. What does the pressure gauge shutoff valve do and when and how do you use it?

   (Answer: The pressure gauge shutoff valve cuts off the flow of oxygen from the high pressure lines leading from the O_2 regulator to the warning whistle and test gauge. It should be used only if you suspect a leak in the pressure gauge or the pressure gauge line as shown by a sharp drop in the gauge reading. To use it, lift the lever about 30° to 45° from horizontal and then watch the pressure gauge reading. If there is a leak, the gauge reading will fall quickly and the warning whistle will sound for 20 to 60 seconds at a reading of 20 to 25 percent of the full cylinder pressure. If these two things occur, leave the shutoff lever in the "up" position. If the gauge reading does not drop after you activate the shutoff valve, there is no leak in the gauge line. Put the shutoff lever back down in its original position.)

5. What does the manual bypass valve do and when and how do you use it?

   (Answer: The manual bypass valve sends oxygen directly from the oxygen cylinder to you. Use it only when you aren't getting the required 1.5 liters of oxygen per minute. To use it, press the red-rimmed, black button for an instant and release it.)

6. Name the two pressure gauges on the BG 174-A and tell what they measure.

   (Answer: The chest pressure gauge measures the oxygen pressure going into the apparatus from the oxygen cylinder. The cylinder pressure gauge measures the pressure in the oxygen cylinder itself. When you are wearing the apparatus, these two readings should be equal.)

7. When the warning whistle sounds, what does that tell you?

(Answer: It warns you that you have only 20 to 25 percent of the original amount of oxygen left in your oxygen cylinder, or about 45 to 60 minutes' worth of oxygen. It also alerts you to a high-pressure leak which has depleted your oxygen supply to the point that the whistle sounds.)

8. What are the two types of regenerative canisters used in the Draeger apparatus and which one can only be used for actual rescue work?

(Answer: The refillable training canister and the factory-packed, disposable canister. The factory-packed, disposable canister is the only one to be used for rescue work.)

9. In the lung demand assembly, what do the pressure relief valve and the lung demand valve do and how do they do it?

(Answer: The pressure relief valve keeps excess oxygen from building up in the breathing bag. Excess oxygen causes the breathing bag to overinflate. This puts positive pressure on the diaphragm which pushes out against a spring. The diaphragm moves away from a sealing bolt, revealing an opening in the diaphragm through which the air escapes to the outside.

The lung demand valve lets more oxygen into the breathing circuit when it is needed. If more oxygen is needed than is being supplied, the breathing bag deflates, putting negative pressure on the diaphragm. This forces the diaphragm plunger inward against the valve's pin lever which opens the valve, allowing medium-pressure oxygen to flow in through the oxygen line from the pressure reducer.)

PUTTING ON THE APPARATUS

Objective 3: The team members will put on and take off the apparatus correctly and check it for proper functioning.

Note: Apparatus testing is covered in the "Testing Procedures" section found further on in this module.

After testing, it only takes a few minutes to put on the apparatus and get under oxygen. During testing, you already have attached the breathing hoses, inserted a fully charged oxygen cylinder and the proper regenerative canister (a refillable canister for training, or a factory-packed canister for actual rescue work). You're now ready to prepare the facepiece and slip on the apparatus.

READEX FICHE

Demonstration: As you discuss this procedure, either put the apparatus on yourself or have a team member put it on. Make sure you cover each step thoroughly.

Note: Do not use an antifog solution that contains alcohol. Alcohol can cause premature aging or cracking of the facepiece's acrylic lens. You should use only the approved antifog solution.

Coating the inside of the facepiece lens with antifog solution is the first thing you do when putting on the apparatus. Also, if your facepiece is equipped with a wiper, you'll want to make sure the wiper is well lubricated with an antifog solution. Then you can slip on the apparatus.

Note: If you are using Draeger K-75 Demister, this antifog solution should be applied at least 60 minutes before the facepiece is put on. It can be applied to the lens before the facepiece is stored after cleaning and disinfecting. For other brands of antifog solutions, be sure to follow labeled instructions.

Putting on the apparatus is easier if there is someone to assist you. Have your assistant hold the apparatus so that you can slip on the shoulder straps. If you don't have a helper, rest the apparatus on a table or other flat surface and back up to it. Then put your arms through the straps.

Once you've gotten the apparatus on, adjust the shoulder straps for a comfortable fit by pulling down on the rings at the ends of the straps.

Then fasten and adjust the waist belt, and hook up the breathing hoses to the spring hook on the tension reliever strap which extends from the right shoulder strap. This will relieve some of the weight of the breathing hoses from the facepiece.

Next, the breathing hoses are attached to the facepiece and hand-tightened. Slip the facepiece's neck strap around your neck so that the facepiece can hang on its own.

Now turn on the apparatus. Remember, you want to open the valve fully and then turn it back a half turn. When the valve opens, hold the facepiece close to your face. You should hear the preflushing action, followed by the sound of the constant-flow metering. You might also hear the warning whistle chirp.

Note: The procedure given here for putting on the facepiece is the manufacturer's recommended procedure.

Putting on the facepiece comes next. First, make sure the head harness is pulled away from the inside of the mask. This helps protect the lens from being scratched. Pull it down over the outside of the lens so that it is sort of inside-out. Then put your chin into the bottom of the mask and pull the head harness up and around your head. Make sure that the harness web is straight against the back of your head. Check that the facepiece is properly seated against your face for a good seal.

Once you have the facepiece in place and the harness around your head, you can tighten the straps, starting with the two straps near your neck. Then tighten the two temple straps, just above your ears. Remember, these are quick adjust straps so all you need to do is pull them until they are tight enough.

The top strap should be the last strap to adjust, if necessary. With most models in the field, the top strap is not a quick-adjust strap. This strap should be preadjusted by you for your head and then left that way. It is not necessary to loosen this strap when taking off or putting on the mask. However, later versions of the Panorama Nova facepiece include a quick-adjust top strap which can be adjusted as necessary immediately after putting on the mask.

Note: If the top strap is not preadjusted, it should be adjusted for proper fit prior to tightening the other four facepiece straps.

Once you have the facepiece on, check the airtightness of it by squeezing both breathing hoses with your hands while at the same time trying to inhale and exhale slowly, yet forcibly.

When inhaling or exhaling, no air should leak in or out. When exhaling, significant pressure should build up in the mask before leaking between the facepiece and face, indicating a good facepiece seal.

Now, the last step is to check the chest pressure gauge to see that you still have a fully charged oxygen cylinder. Never overlook checking the pressure, even if it was just checked when you tested the apparatus.

Each team member and apparatus should then be rechecked by the team captain. The team captain and his or her apparatus should be rechecked by a team member.

TAKING OFF THE APPARATUS

Demonstration: As you discuss the following procedure, demonstrate how to properly take off the apparatus.

There is also a proper way of taking off the apparatus.

First of all, leave the apparatus turned on.

Remove the facepiece, and let it hang around your neck.

Disconnect the tension reliever strap from the breathing hoses.

Loosen the wearing harness. To loosen the quick-release straps, put a thumb or finger under the tab of the buckle and lift upward. This should loosen the connection so that the strap can slip through.

Then carefully disconnect the breathing hoses from the apparatus, and ensure that no saliva or condensation from them flows or drips into the demand valve assembly. This is especially important if the apparatus is to be transported prior to cleaning and disinfecting. The demand valve assembly can be impaired if liquid drips into it.

Now, carefully take off the apparatus. Again, if you have a teammate to help you, have that person hold the apparatus as you slip out of it.

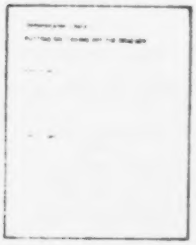
Now you can turn off the apparatus by closing the cylinder valve.

Then, immediately after turning off the apparatus, disconnect both canister connections and remove the canister. Do this even if you aren't immediately going to clean and disinfect the apparatus. It prevents caustic liquid in the canister from entering other parts of the apparatus, especially the oxygen control group.

Disconnect the preflush/dosage line from the elbow connection on the canister. Remember that this is a finger-tight connection. This is especially important if the apparatus is to be transported prior to cleaning and disinfecting. Disconnecting the preflush/dosage line will protect the oxygen control group by keeping moisture from going down the line.

Then, clean and disinfect all the parts that were exposed to the circulating air. This procedure will be covered shortly.

Demonstration check: Have each team member put on and take off the apparatus. Use copies of the *Demonstration Check 1 - Putting On, Taking Off the Draeger* form provided at the back of this module to check each team member's performance. Review the results with each team member.



WEARING THE APPARATUS

Objective 4: The team members will define the apparatus's limitations when it is worn, and practice wearing the apparatus.

After checking the facepiece seal and the cylinder pressure, you are ready for training or rescue work. Remember, the BG 174-A will function automatically while you work. It will provide you with approximately 1.5 liters of oxygen per minute, and more than that if necessary.

The only things you'll need to do by hand are:

1. Occasionally check the chest pressure gauge for the current cylinder pressure;

2. Press the bypass valve button if you are not receiving enough oxygen and you are sure it is an emergency; and

3. Lift the lever of the pressure gauge shutoff valve if you suspect a leak in the chest gauge or the chest gauge line. If there isn't a leak then you must put the lever back down in its original horizontal position to allow the chest pressure gauge to read the actual cylinder pressure and to allow the warning whistle to function. Remember, the shutoff valve closes the lines leading to the gauge and the warning whistle.

Generally speaking, if everything is operating smoothly, an occasional glance at the chest pressure gauge is all you'll need to do while wearing the apparatus. Of course, your captain will stop the team periodically and check to see how each team member is doing. During this check, the captain will also check your pressure gauge reading and inspect your wearing harness and facepiece.

Limitations

We talked generally, in the Introduction to Self-Contained Breathing Apparatus module, about some of the limitations placed on you when you wear an apparatus. Understanding these limitations and learning to cope with them can have a significant effect on how well you do your job.

Note: At this point you may wish to review the general limitations from the *Introduction to Self-Contained Breathing Apparatus* module (MSHA 2003).

We'll look now at the specific limitations of the Draeger apparatus. You should be thinking about these limitations, and learn to deal with them during training sessions. When you're working on a rescue operation, you're going to want to work as naturally and efficiently as possible.

Weight and Size of Apparatus

When wearing the apparatus, you've got an extra 30 pounds to carry around. Working and moving with this extra weight is something you will have to get used to during your practice sessions.

Even though the apparatus has a slim profile, you might have to remove the unit from your back in order to get through narrow passageways.

If a passageway isn't wide enough for you and the unit back-to-back, you can take off the unit, being careful not to disturb the facepiece. The unit can then be slid or carried in front of you without interrupting your breathing cycle.

Note: Remind the team of the design of the cover, especially the ridges on it which allow sliding. Also remind them *never* to remove the facepiece when they take off the apparatus to slide or drag it or allow the weight of the apparatus to break the face-to-facepiece seal.

BG 174 note: Remember, this apparatus only has a two-hour approval.

Visual: Again point out the unit's approval duration, which is located on the approval label, and/or refer again to "Visual 3" for a picture of the approval label.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Time Limit, Work Rate, and Breathing Rate

Any breathing apparatus you use will limit the time you'll have in which to work. The BG 174-A is approved for three- or four-hour use.

Remember, when there is 1800 PSI in your cylinder, you'll have enough oxygen to supply you while you're doing moderate work for about two hours. At 2600 PSI, you'll have about three hour's worth, and at 3135 PSI, you'll have enough to breathe independently of surrounding air for up to four hours.

Your Draeger unit is approved for two-, three-, or four-hours use when you're working at a moderate rate. But no matter how much oxygen you have, working harder can further limit the amount of time you'll have under oxygen.

This occurs because the harder you work, the faster and deeper you breathe. If you're working extremely hard, you'll use more oxygen and you'll use it up faster than the two, three, or four hours for which your apparatus is approved.

The air you breathe through the apparatus may get warm or hot and have a lot of moisture in it.

Heat buildup within the unit's system is produced when your exhaled air flows through the regenerative canister. This canister removes carbon dioxide by means of a chemical reaction, which produces heat.

Some of this heat is transferred through the back of the unit away from you. But some of it unavoidably remains in the system, increasing the temperature of the air you breathe.

Usually, the temperature in the system won't rise much beyond 95° F (35° C). In extreme conditions, it may rise to 105° F (41° C) maximum.

Breathing this hot air laden with moisture created by condensation of the water in your breath can cause additional stress, especially when you're working extremely hard.

Note: You might wish to mention that the "extra stress" this creates is something akin to working on a hot, humid day vs. doing the same work on a cool, dry one.

This heat will be more of a problem during your training because you'll be using reusable canisters which produce more heat than the factory-packed canisters you'll be using during actual rescue and recovery work.

The heat and moisture produced within the unit can also cause the facepiece to fog, making it difficult for you to see. This is why you should always use an antifog solution on the lens before you put on the facepiece. This solution prevents moisture from adhering to the lens. If your facepiece is equipped with a wiper you can use the wiper to clear the lens.

Temperature Range

Under the "limitations" heading on your Draeger unit's approval label, you'll find its rating for cold weather use. On most units, this is +32° F (0° C).

Visual: Point out the cold weather rating on the approval label of the apparatus, and/or refer again to "Visual 3" for a picture of the approval label.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

This temperature rating is a little misleading. That rate was originally given to all apparatus tested after 1968. Since that time, the Draeger BG 174-A has been approved for use down to +14° F (-10° C).

Even if you're fighting a fire while wearing the Draeger apparatus, things would have to get really hot–about 300° F (145° C) with a full, four-hour oxygen cylinder–before heat would affect the unit's operating capabilities. With a cylinder having 2000 PSI oxygen, the air temperature would have to reach 700° F (371° C) before heat would activate the pressure-burst cap.

Obviously, the apparatus can withstand much more heat than you can.

Note: At this point you may wish to again mention the unit's pressure-burst cap, located on the oxygen cylinder. The cap allows oxygen to escape slowly when the cylinder gets so hot that the expanding gas might otherwise cause it to explode (4450 PSI). This pressure corresponds to the maximum temperatures you're discussing here.

Wearing Schedule

Note: A *Suggested Wearing Schedule* for the apparatus is included at the back of this module. It is designed to allow the team members to become familiar with the apparatus and what it is like to wear and work with the apparatus. It presents a three session practice schedule of exercises and procedures for the wearing of the apparatus. It is recommended that these practice sessions be conducted after you have finished presenting the training contained in this module.

Review questions: Ask the team members the following questions. Allow time for them to answer and then discuss the correct answers with them so they fully understand the material covered in this section.

1. When wearing the BG 174-A, what are three things you will or might need to do by hand?

   (Answer: Occasionally check the chest pressure gauge for the current cylinder pressure; press the bypass valve button if you aren't getting enough oxygen and you're sure it's an emergency; lift the pressure gauge shutoff valve lever if you suspect a leak in the gauge or gauge line. If there isn't a leak, move the lever back down to its horizontal position.)

2. List several limitations to the BG 174-A.

   (Answer: Refer back to the section just covered for correct responses. Answers given should fall under the topics of weight, time, work rate, size, cold, heat, breathing, seeing, communication, beards, or others listed for your operation. Specific details can be checked in the section of the module just covered.)

BENCH DUTIES

Objective 5: The team members will perform required and recommended testing and maintenance of the Draeger BG 174-A.

Note: The rest of this module is about apparatus testing and maintenance. Since testing and maintenance programs differ from one mine to another, this section is designed so that you can adapt it to fit your own training needs. Simply use the parts that fulfill your own training needs and leave out those that don't.

When you're under oxygen, every move you make depends on the smooth and proper operation of your breathing apparatus. And your team's performance level can only match that of its individual members–including you.

This is why it's almost impossible to over-emphasize the importance of keeping your apparatus in top condition. You can keep it operating properly only by testing and maintaining it on a regular basis.

Note. You may wish to point out that the term "bench duties" is sometimes used in reference to testing and maintenance procedures because the tests are often performed with the units resting on a table or bench.

Cleaning and Disinfecting the Apparatus

Demonstration: For these sections on cleaning and disinfecting the apparatus, demonstrate the procedures on an apparatus as you discuss them. Either demonstrate them yourself or have a team member do it.

Reference: For more detailed information on cleaning and disinfecting, refer to the Draeger *Operating Instructions* manual packed with the apparatus.

After each use, the oxygen cylinder and all parts exposed to the breathing-circuit air must be removed from the apparatus and cleaned and disinfected.

Removing the Exposed Parts

Here is the procedure to follow when removing the apparatus parts:

1. **First, remove the protective cover.**

2. **Then, remove the regenerative canister. To do this, unscrew the bag-connecting sockets from the canister so that the canister can be removed.**

Note: The canister will probably be quite hot, so use caution when removing it.

If you used a factory-packed, disposable rescue canister, throw it away immediately so that the fluid inside does not get on your skin or other surfaces.

If you used a refillable training canister, it must be emptied immediately after use. Also, occasionally wash it out to remove all chemicals that can build up in the bottom of the canister. Dry the canister thoroughly afterward.

3. Now remove the oxygen cylinder. As a safety feature you will only be able to loosen the hand-tight connection if the apparatus is completely depressurized, so don't force it if there's still pressure in the system.

4. Then detach the breathing hoses from the facepiece.

5. Take off the saliva trap cap and empty out the saliva. A wrench will be needed for this.

6. Remove the breathing bag, very carefully. (Unscrew the sockets and the preflush/dosage line.)

7. Detach the oxygen line from the demand valve assembly with a wrench, and remove the assembly from the apparatus.

8. Finally, remove the diaphragm from the diaphragm casing of the valve assembly. This casing should be cleaned using a soft-bristled brush or rag.

Now you're ready to clean the various parts.

Washing, Rinsing, and Drying

Specifically, the parts which have to be cleaned are:

1. The facepiece;
2. The breathing hoses and saliva trap;
3. The breathing bag; and
4. The demand valve assembly.

Before cleaning the demand valve assembly, you'll want to keep water from getting into the demand valve. For this reason, a plug assembly is provided in the tool kit, and is to be inserted in the valve.

To install the plug, first screw in the threaded end onto the oxygen line on top of the valve. The split rubber plug at the other end is then encased around the valve stem and inserted into the recess of the demand valve, thus protecting the valve from water. The rubber strap connecting the cap and plug is a safety feature designed to prevent you from leaving this assembly attached to the demand valve. Any broken straps should be replaced immediately.

All these parts should be thoroughly washed in a cleansing/disinfectant solution. This solution must be recommended for sterilization of rubber or Neoprene parts, and should be properly diluted. Otherwise the rubber parts will deteriorate and have to be replaced more often than is recommended.

After washing, the parts should be thoroughly rinsed in warm water to remove all the disinfectant solution.

Then the parts should be dried, either by hanging them from a line in a dry, well-ventilated, clean room or with a drying unit designed for this purpose. If this is not possible, you can use a blow-dryer set on a cool temperature – not above 140° F (60° C). You should not use compressed air because it could deposit oil on the equipment.

And when you're hanging up these pieces, do not hang them in direct sunlight or indirect fluorescent lighting because both sunlight and fluorescent lights can harm the rubber parts.

As for cleaning the outside of the apparatus, you should occasionally wipe down the protective cover and harness with a damp cloth.

Reassembling the Apparatus

When everything is clean and dry, you can remove the rubber plug from the demand valve and replace the demand assembly in the apparatus.

Then replace the breathing bag and the saliva trap cap (using a wrench). When replacing the breathing bag, the Draeger emblem faces outward and the threaded connection with the slot must be lined up with the bar on the lung demand assembly.

Storing the Apparatus

You should be careful to keep the parts of the apparatus as free as possible from moisture and dirt. To protect the apparatus from dust, dirt, and moisture, you should keep it in the storage/carrying case whenever you are not using it. And always store the unit in a convenient location so as to ensure readiness for immediate use.

Note: Title 30, *Code of Federal Regulations (30 CFR), Section 49.6(b)* requires that apparatus be stored and maintained in a manner that will ensure readiness for immediate use.

When packing the apparatus in the case be careful not to distort the rubber parts of the facepiece and hoses.

Note: If you are using Draeger K-75 Demister as an antifog solution, it should be applied to the facepiece lens just before putting the apparatus in storage.

Demonstration check: Have each team member remove the exposed parts, disinfect, and reassemble the apparatus. Use copies of the *Demonstration Check 2–Cleaning and Disinfecting the Draeger* form provided at the back of this module to check each team member's performance. Review the results with each team member.

Oxygen Cylinders

Oxygen cylinders are designed to contain oxygen under high pressure. For that reason they must be in good condition and properly handled and stored at all times.

Before the cylinders leave the factory, they must meet the construction specifications of the Department of Transportation (DOT) and be rigidly tested by an independent inspector licensed and certified by DOT. Then, after the cylinders leave the factory, they must be retested hydrostatically every 5 years.

Note: When a cylinder is hydrostatically tested, it is filled with water to a pressure greater than its normal operating pressure, forcing the cylinder to expand. The hydrostatic test measures the elasticity of the cylinder as the cylinder expands.

Hydrostatic Testing

Hydrostatic testing is important because it will reveal any inside deterioration of the cylinder. One cause of inside deterioration is moisture in the cylinder.

Moisture is carried into the cylinder when the cylinder is filled with oxygen. The moisture hastens oxidation of the steel bottle causing sediment, rust, and pitting, and weakening of the cylinder walls. These changes occur with no visible signs on the outside of the cylinder. Hydrostatic testing is the only way to determine the complete condition of the cylinder.

The date of the hydrostatic test is stamped on the outside of the cylinder (usually near the neck) for easy reference in determining when the cylinder must be tested again. Remember, the cylinder must be hydrostatically tested every 5 years.

Visual: Display an oxygen cylinder and point out where the hydrostatic test date is located. Also point out where the pressure service rating is stamped as you discuss the following section.

Pressure Service Rating

Also stamped near the neck of the cylinder is the pressure service rating. The pressure service rating is the maximum pressure that the cylinder is approved to hold.

Usually there is a plus sign (+) stamped on the cylinder next to the hydrostatic test date. If this "plus" is stamped next to the most recent hydrostatic test date, it means the cylinder can hold another 10 percent of the pressure service rating. Ten percent of 2850 PSI is 285. Add that to 2850, and you have a grand total of 3135 PSI. Never fill a cylinder higher than the total service pressure marked on it.

Visual: Point out the pressure service rating number and the "+" sign on the cylinder. Remember that if the cylinder has a "+" sign next to the *most recent* test date, it can hold an additional 10 percent of the stated service pressure. For example, 10 percent of 2850 PSI is 285 PSI. 2850 PSI + 285 PSI = 3135 PSI.

Note: Each time the cylinder is retested, it may or may not obtain the "+" rating. The "+" must be stamped *each time* the cylinder is tested (if it is "+" rated). It is important that the team know this.

If there is no "plus" stamped next to the most recent test date, the cylinder can only be filled to the pressure service rating marked on it - without the extra 10 percent. For example, your cylinder may be marked simply "2600" or "2850." If that's the case, never fill it beyond the pressure marked on it.

Handling and Storing Oxygen Cylinders

Oxygen can be dangerous near fire or sources of ignition (such as a lit cigarette). Oxygen causes a flame to burn with more intensity. In effect, it can "feed" a fire. So it is very important that combustible materials and sources of ignition be kept away from the area where you are filling or storing oxygen cylinders.

No open flames should be around the oxygen and smoking must be prohibited. No hydrocarbon oil, grease, or combustible materials should be used or stored around oxygen equipment.

All equipment used for filling cylinders, such as an oxygen pump, connections, hoses, cylinders, and the apparatus itself must be clean and free of oil and grease, or unapproved lubricants.

Note: Use only cleaning solutions approved for use with oxygen.

The area where oxygen cylinders are filled and stored must have adequate ventilation to prevent a buildup of oxygen and reduce the potential for fire.

If the cylinders are stored outside the apparatus they should be put in racks or held in place by chains so that they do not fall over or onto the floor. And the room or area that the cylinders are stored in should have a temperature of about 70° F (21° C).

If handling cylinders, use caution. Be careful not to drop or knock over a cylinder.

Don't use a wrench or hammer to open or close a cylinder valve. The valve should only be tightened or untightened by hand.

Finally, when being transported outside the apparatus, cylinders should be secured. The valve should be tight and have the cylinder cap or dust cap screwed on.

Filling Oxygen Cylinders

There are two methods of filling oxygen cylinders at a mine site: the cascade system and the high-pressure oxygen pump.

Reference: The reference for the following regulation regarding what method of filling to use is 30 *CFR*, section 49.6(a)(4).

The cascade system can be used to recharge a cylinder when the pressure service rating is 2400 PSI or less.

The high-pressure oxygen pump (also called a booster pump is generally used to recharge a cylinder to higher pressures but can be used for lower pressures. Nevertheless the high pressure pump must be used when the cylinder's pressure rating is above 2400 PSI.

Note: The cascade system or the oxygen pump can be used to fill the Draeger's 2-hour cylinder with a pressure rating of 1800 PSI.

The oxygen pump must be used to fill the Draeger's 3- and 4-hour cylinders with pressure ratings of 2600 PSI and 3135 PSI, respectively.

Note. There are several types of oxygen pumps that can be used to fill the oxygen cylinder of the Draeger apparatus.

This section of the lecture covers *general* procedures and precautions to be followed when filling the Draeger oxygen cylinder. For more detailed information on using the oxygen pump, refer to the manufacturer's instructions or the Bureau of Mines', *Mine Rescue Apparatus and Auxiliary Equipment A Handbook for Miners* by Morrow, Demkowicz, and Chastain.

Reference: For more detailed information on filling oxygen cylinders, refer to the Draeger *Troubleshooting and Maintenance Manual* packed with the apparatus.

When filling a cylinder, use only United States Pharmacopoeia (USP) medical oxygen. Other grades of oxygen may contain impurities or excessive moisture that can affect the cylinder's operation.

Before filling a cylinder with oxygen, you should look over the cylinder and check some things to make sure the cylinder is in good condition:

1. Inspect the cylinder for dents and corrosion. A badly corroded cylinder could rupture under pressure. Damaged cylinders should be returned to the manufacturer.

2. Check the hydrostatic test date and the pressure service rating stamped on the cylinder. Remember, a cylinder is only good for 5 years after it has been tested. If it has been more than 5 years, the cylinder must be returned to a certified testing facility to be retested hydrostatically.

   Also remember that the cylinder cannot be filled beyond its pressure service rating (1800 PSI; 2600 PSI; 2850+ or 3135 PSI).

Note: Remember that the "+" sign located on a cylinder means that the cylinder can be filled to that service rating *plus* an additional 10 percent. 2850 + PSI equals 3135 PSI.

3. During training, you should try to maintain at least 500 PSI in the cylinder at all times. If this small amount of pressure is not maintained in the cylinder, outside air and moisture could enter the cylinder and foul the oxygen or cause the inside of the cylinder to corrode.

   Particles of corrosion could get into the oxygen control group and foul it. Should this happen, sieves in the oxygen connection of the control group could get clogged and affect the performance of the oxygen regulator. (The preflushing action of the apparatus could be insufficient or not work at all.) If this happens, return the oxygen control group, along with the cylinder, to the manufacturer for repair and retesting.

If you have an oxygen cylinder showing zero pressure on the gauge, it should be marked or tagged as empty and returned to the manufacturer or a certified testing facility so that it can be purged and vacuumed to remove the moisture and contaminants. The valve on an empty cylinder should be kept closed to prevent further contamination in the cylinder.

If you're using an oxygen pump to fill the cylinder, the pump itself should have a filter dryer installed on the gas inlet side of the pump to prevent moisture and dust from getting into the oxygen. The filter should be changed or refilled regularly.

4. Before filling the cylinder it is a good practice to crack the cylinder valve slightly and then close it. This will blow out any dust and moisture that may have accumulated in the valve. When doing this, make sure the valve opening is pointed away from your face to avoid getting dust or dirt blown into your eyes.

When filling bottles at high pressures they should be placed in a strong container or holder to prevent injury in the event the bottle busts or explodes.

Also, when filling the cylinders, the temperature in the room or area you are working in should be about 70° F (21° C). The reason for this is because oxygen expands in higher temperatures. If you fill a cylinder in a very warm room, the oxygen expands to a high pressure. If this filled cylinder is then stored in a cool room, the oxygen will contract to a lower pressure and it won't be a fully charged cylinder when you're ready to use it.

The reverse could also happen: If you fill a cylinder in a cool room and then store it in a warm place, the oxygen will have a tendency to expand as the pressure increases in warmer temperatures. And the increasing pressure could go beyond the pressure service rating for that cylinder.

Note: Some brands of pumps are equipped with a safety feature which automatically shuts off at a preset pressure.

If you use a high-pressure pump to fill the cylinder, the temperature in the cylinder will rise according to how fast the pump is working. After filling the cylinder, let it cool for 15 to 20 minutes. The pressure reading on the cylinder will probably drop. If so, fill the cylinder once more to the correct pressure.

If the cylinder is going to be stored or transported after filling it, screw the metal cylinder cap onto the cylinder valve connection to keep dust and moisture from getting into the valve and to protect the coupling threads. The cap should be kept screwed on the cylinder valve and removed only when the cylinder is being filled or when it is connected to an apparatus.

Note: Oxygen cylinders should only be filled with oxygen. Do not use an oxygen cylinder for storage of any other type of gas.

Testing the Draeger

Note: Depending on how your training program is set up, the team members may or may not be responsible for testing their own apparatus and keeping records. You may leave out information in the next sections that doesn't apply to your program. *However, it's important for all the team members to know what the law says with regard to inspection and recordkeeping.*

As you have seen thus far, there are a lot of parts and functions on the Draeger breathing apparatus. Every one of these parts must, at all times, be in perfect condition, and everything must work precisely as it was designed to work. If there is less than perfect operation anywhere, the unit will work either less efficiently, or not at all. And if the unit doesn't function properly, neither will you.

To help assure correct functioning, test the apparatus regularly. Testing is an important part of using the apparatus, for just as you wear the apparatus regularly, you must also test it regularly.

Federal law requires that the apparatus be tested and inspected at least once every 30 days.

Reference: The reference for the testing and inspecting requirement is 30 *CFR*, Section 49.6(b).

Also, the apparatus should be tested before it is worn for actual rescue work, especially if it has been transported to the mine site. A trip down a bumpy road in a truck could loosen couplings or otherwise cause the apparatus to function improperly.

And don't think that there isn't enough time to perform a test before going to a rescue—because you have to make the time. Once you become experienced with the test procedure you should be able to run through it quickly and accurately. Afterwards, when you're wearing the apparatus and you're counting on it for oxygen, you'll be confident that your unit is dependable.

Recordkeeping

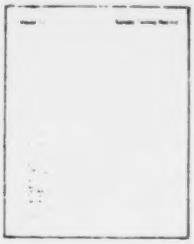
Keeping records of tests and repairs made on your apparatus is an important means of ensuring that your unit is always dependable. Accurate, well-kept records can tell you at a glance what condition your unit is in.

When kept over long periods of time, records help to identify your unit's "weaknesses" and help you spot minor trouble areas that could turn into major malfunctions. Records also provide you with a basis for developing a replacement schedule for expendable parts.

Testing Records

Visual: Refer to "Visual 12" for a picture of a sample testing record.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Reference: The reference for testing records is 30 *CFR*, Section 49.6(b).

Federal law requires that you keep an accurate record of each test performed on the apparatus. This record must be kept at the mine for one year.

This record, which may be designed as a checklist, should include all the tests and inspections performed on the apparatus. It should also include the test date, the name of the person performing the test, and the serial numbers on the apparatus, oxygen cylinder, lung demand valve assembly, and oxygen control assembly.

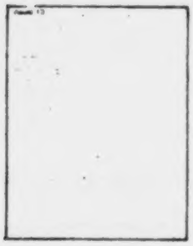
The record should also note what parts, if any, need to be replaced.

Maintenance Records

In addition to the testing record required by Federal law, it's also a good idea to keep a separate maintenance record for each apparatus.

Visual: Refer to "Visual 13" for a picture of a sample maintenance record.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



A maintenance record should include:

1. **The total number of hours the apparatus has been used;**
2. **The installation date for any new part that has been put on the apparatus; and**
3. **The date on which the apparatus was first placed in service (if known).**

A record like this one helps you establish a regular maintenance program for each apparatus. This is much like the maintenance schedule you use for your car, except that here you use "total hours used" as a basis for figuring out what parts should be replaced and/or inspected rather than the car's "total miles traveled."

Note: At this point, discuss your mine's schedule for and/or experience with replacing expendable parts such as hoses, washers, "O" rings, etc.

Visual: Refer to "Visual 14" for a picture of these maintenance and inspection tags.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Tagging

Besides keeping detailed maintenance and inspection records, it's also a good idea to keep a record of the unit's last inspection on a tag affixed to each unit. Then the person who wears the unit next will know when it was last tested and whether it's ready for use without having to look it up on the chart. This can be a real timesaver during an actual emergency.

These tags should be placed on the unit every time it is inspected. Along with the date of the last inspection, the tag should also include information such as:

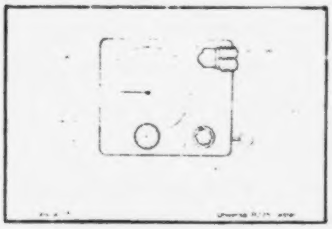
1. The name or initials of the person who inspected it;
2. Any parts removed for repairs; and
3. Whether the unit is functioning properly and if it's ready for use.

It is suggested that a white tag be used if the unit has passed all inspection tests and is ready for use. If the unit is not functioning properly or has a part removed for repairs, a red tag should be used. Thus, you will know immediately by the color of the tag whether the unit can be used.

The Universal Rz25 Tester

Visual: Point out the following parts on an Rz25 Tester, and/or refer to "Visual 15" for a picture of the tester.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The Draeger Universal Rz25 Tester is used to test the apparatus. It is an instrument capable of monitoring every function of the apparatus.

Basically, the tester has:

1. A bellows, somewhat like a pump, for forcing air into and out of the apparatus; and
2. A meter for measuring the functions of the apparatus. This tester meter is marked off either in millimeters water (mm H^2O), or in millibars (mbar), depending on when the tester was made. The more recent testers are marked off in millibars, and read from -10 to +10.

Note: Both millimeter (mm) and millibar (mbar) measurements will be given in the following lecture, but it won't be necessary to read both. Check to see which model of the tester you have, and then tailor the lecture to read either mm or mbar.

The millimeter water gauge is marked off in increments of 10, and reads from -100 to +100.

The other features of the tester are:

1. A stopwatch mounted on the lower portion of the meter;
2. A zero-set knob for zero-adjusting the tester meter before beginning the test. This knob is located in the lower left-hand corner of the tester;
3. A test-selector knob for "programming" the tester to whichever test you will be performing on the apparatus. This is the large black knob on the right side of the tester;
4. A red "air-escape" button which you press to bleed the meter needle down or up to an exact reading;
5. A handle for the bellows, located behind a sliding panel on the right side of the tester. This is an extending handle, so you have to pull it out when you're ready to use it:
6. A hose connection and adapter for coupling the breathing hoses to the tester; and
7. A hose for testing the dosage directly from the oxygen regulator.

Remember, this tester is an instrument for measuring, and it should be handled carefully to ensure its accuracy. When you are finished using it, take out the hose adapter and store it in the lid. Then make sure to cap-off the hose connection with its cover and close the sliding panel to the bellows handle. This will prevent dirt or other objects from getting inside the tester.

Also, to further ensure the accuracy of the tester, it is a good idea to test the tester occasionally.

Testing the Tester

Demonstration: Perform this test on the tester as you discuss the procedure.

To perform the test: Plug the hose connection on the tester with your finger or the small tapered end of the relief valve plug found in your tool kit. Then, to test for air leaking out of the system: Put the selector knob on "positive pressure pumping" and pump until the meter needle reads +100 mm H_2O (+10 mbar). Then switch the selector knob to "leak test," bleed the needle down to +70 mm H_2O (+7 mbar) (this is done by pressing down on red "air-escape" button), and start the stopwatch. Observe the needle for 60 seconds; it should not drop more than 2 mm H_2O (0.2 mbar).

Now, to test for air leaking into the system: With the hose connection still plugged, put the selector knob on "negative pressure pumping" and pump until the meter needle reads -100 mm H_2O (-10 mbar). Then switch the selector knob to "leak test," bleed the needle up to -70 mm H_2O (-7 mbar) (again by depressing red "air-escape" button), and start the stopwatch. Observe the needle for 60 seconds; it should not rise more than 2 mm H_2O (0.2 mbar).

You should keep a record of this test, noting the test date, results, the unit number, and the name of the person who performed the test.

Testing Procedure

Visual: Distribute copies of the "Visual 16" handout which is a guide of the 15 testing procedures. You may also refer to an overhead transparency of the visual as you discuss each test with the team.

There are 15 steps to the testing procedure, starting with removing the apparatus from its case. You should pay particular attention to the testing sequence because it follows an efficient order. You will find, after becoming familiar with the procedure, that there is a minimal amount of work involved. Each test pretty much prepares the way for the next test.

Step 1: Visual Inspection

Demonstration: For this test and the 14 that follow, perform the tests with the tester and a BG 174-A as you discuss the procedures. Have the team members follow your demonstration by using the "Testing Procedure" handout ("Visual 16").

Take everything out of the carrying case, so that the apparatus, facepiece, and breathing hoses are laid out in front of you. Make sure you have antifog solution and wiping tissue for the facepiece.

Look over the apparatus and make sure the protective cover and harness are in good condition. This includes examining all straps and metal fittings. Now lay the apparatus on its harness and remove the cover.

Step 2: Insert Oxygen Cylinder

You must insert a fully charged oxygen cylinder if you are testing the apparatus just prior to wearing it, whether for training or for actual rescue work.

Note:

Cylinder Pressure	Approved Time, Amount of Oxygen
1800 PSI	2 hours
2600 PSI	3 hours
3135 PSI	4 hours

However, if you are performing a routine monthly test on the apparatus and are not going to wear it, you can use a cylinder which is not fully charged, but is pressurized to at least 1400 pounds per square inch. If there is less than 1400 PSI, the test results will not be accurate.

Before connecting the cylinder to the oxygen control assembly, check the condition of the "O" ring and screen in the hand-tight connection.

Step 3: Insert Regenerative Canister

If you are preparing to go into an actual rescue and are inserting a factory-packed, disposable canister, you first want to check to see that the string seal has not been broken, and the canister has not expired. The expiration date, remember, is stamped on the factory label.

If these are okay, then you can unscrew and remove (with a wrench if needed) the inlet and outlet caps on the canister, and insert the canister into the holder. When doing this, make sure the arrow on the canister points in the same direction as the arrow on the holder.

Check the gaskets in the breathing bag elbow sockets and then connect the sockets to the inlet and outlet of the canister.

If a refillable canister is used for training purposes or for routine testing, before filling it, check to see if the screens in the inlet and outlet of the canister need to be cleaned. If necessary, clean them with a brush.

Now completely fill the canister with the absorbent chemical. Fill it a third at a time, shaking and tapping the canister after each third. This gets all the chemicals to settle, allowing no air spaces inside. Top off the canister as best you can—a scoop and funnel work well if you have them.

Then, after checking the gasket in the plug connection, put the plug back into the canister, and tighten it with the slotted wrench provided in the tool kit.

Again, when you place the canister in the holder, the arrows should point in the same direction. And check the gaskets before connecting the breathing bag elbow sockets to the inlet and outlet of the canister.

Step 4: Facepiece and Breathing Hoses Examination

Examine the facepiece, breathing hoses, and head harness to make sure they are in good condition. You should see no signs of deteriorated rubber, no cracks in the lens, no torn edges on the facepiece seal. And always be sure to check the hose connections to ensure that the "O" rings have not been dislodged during cleaning.

Now, you are ready to hook up the apparatus to the tester.

Step 5: Exhalation Valve Test

First, zero-adjust the tester by turning the black adjustment knob in the lower left-hand corner of the tester. After this initial adjustment, do not readjust this setting for the rest of the testing.

Remove the cover from the tester's hose connection and screw in the breathing hose adapter, followed by the breathing hoses. This connection should be tight enough to prevent leakage.

To test the exhalation valve: Cap off the exhalation hose and connect the inhalation hose (the one with the saliva trap) to the exhalation valve assembly on the apparatus.

Set the tester on negative pressure pumping and start to work the bellows by pumping with very gentle strokes (you should meet resistance at once). Watch the breathing bag. It should not begin to deflate after 5 seconds, indicating the exhalation valve is working properly; it only allows the wearer's exhaled air to pass into the apparatus—not back out of the apparatus.

Step 6: Inhalation Valve Test

Now to test the inhalation valve: Remove the hose from the exhalation valve, and connect it to the inhalation valve, making sure to position the hose so that the saliva trap is in a vertical position before tightening the connection. This will ensure that the trap is in the proper position when you put on the apparatus.

Switch the selector knob to positive pressure pumping and gently pump. Again watch the breathing bag. It should not begin to inflate after 5 seconds, indicating the inhalation valve is working properly; it only allows the wearer to inhale air from the breathing bag, and not exhale it back into the bag.

Step 7: Relief Valve Test

This test will determine if the relief valve vents as it should when the bag is overpressurized.

First, remove the cap from the exhalation hose and connect the hose to the apparatus at the exhalation valve.

The tester should already be on positive pressure pumping, so start pumping to fill the bag. Once the bag is full, listen for the relief valve to open and/or try to feel the escaping air by wetting a finger and holding it in front of the vent. The valve should open when the meter reads between +10 and +40 mm H_2O (+1 and +4 mbar). Watch the meter while testing.

Note: A more precise test of opening pressure for the relief valve can be conducted right after Step 10, the Preflush/Pressure Gauge Equalization Test. If you wish to do this test, follow the directions in the *Note* at the end of Step 10.

Step 8: Positive Pressure Leak Test

Now you are ready to test for air leaking out of the apparatus.

First, seal the relief valve vent (in the lung demand assembly) with the rubber plug provided in the tool kit. Then plug the opening in the warning whistle with the cover, also included in the tool kit.

Now, the tester should already be set on positive pressure pumping, so pump up the breathing bag until the meter needle reads +100 mm H_2O (+10 mbar).

Then switch the tester to leak test, and bleed the needle down to +70 mm H_2O (+7 mbar).

Start the stopwatch and observe the needle for 60 seconds. The needle should not drop more than 10 mm H_2O (1 mbar).

Step 9: Negative Pressure Leak Test

Now, to check for air leaking into the apparatus, including through the relief valve:

Remove the rubber plug from the relief valve vent only. Don't remove the whistle cover.

Switch the tester to negative pressure pumping and pump the bellows until the meter reads -100 mm H_2O (-10 mbar).

Then switch the tester to leak test and bleed the needle up to -70 mm H_2O (-7 mbar).

Start the stopwatch and observe the needle for 60 seconds. After 60 seconds, the needle should not rise more than 10 mm H_2O (1 mbar).

Step 10: Preflush/Pressure Gauge Equalization Test

BG 174 note: The BG 174 does not have two pressure gauges. Therefore it will not be necessary to perform the gauge equalization test.

First, remove the cover from the warning whistle.

Then set the tester on negative pressure pumping and open the oxygen cylinder valve by placing two fingers on the knob, pulling it out and rotating it counterclockwise. Open the valve fully, then turn it back one-half turn, the method you should always use when you turn on the apparatus.

The breathing bag should completely inflate due to the preflushing action, and there should sound a short chirp of the warning whistle.

When the preflushing is complete, observe the chest pressure gauge to ensure that it reads within 10 percent of the reading on the oxygen cylinder gauge.

Note for Alternate Relief Valve Test: You can now check the opening pressure of the relief valve as explained at the end of Step 7. To do this test, open cylinder valve (with tester set on negative pressure pumping and leak test). The flow of oxygen from constant dosage will cause relief valve to open, with opening pressure indicated on the tester gauge. The valve should open between +10 and +40 mm H_2O(+1 and +4 mbar).

Step 11: Lung Demand Valve/ Breathing Bag Volume Test

Now that the bag is full, you will be pumping the air out of the bag to figure out: (1) how many liters the bag holds, and (2) how much negative pressure is required before the demand valve kicks in. You can figure out both by pumping the air out of the bag, counting the strokes, and listening.

So, with the tester already set on negative pressure pumping, start pumping and count the strokes. Since each stroke of the bellows draws approximately 0.5 liters, it should take at least 10 strokes before the bag deflates enough for you to hear the lung demand valve activate.

You should also get a meter reading of when the valve kicks in, so be watching the needle. The valve should open between -10 and -40 mm H_2O (-1 and -4 mbar).

Step 12: Bypass/Constant Dosage Test

Now that the breathing bag is deflated, you can check to see if the manual bypass valve works to fill the bag in 10 seconds or less. Then you'll be checking to see how much oxygen is metered into the bag when the apparatus is functioning automatically.

Set the tester on the "red" dosage test (0.5 to 2 LPM). Again put the plug in the vent of the pressure relief valve.

Press and hold the red bypass valve and listen for the flow of oxygen into the breathing bag as the bag fills up.

Release the bypass button when the needle reads 1.7 LPM on the outside red scale. The needle should then settle somewhere between 1.4 and 1.7 LPM, indicating that the dosage device is allowing approximately 1.5 LPM of oxygen to constantly flow into the breathing bag.

Note: The permissible dosage range (1.4 to 1.7 LPM) will increase at higher elevations. For example, at 6,000 feet, the permissible range is 1.5 to 1.8 LPM.

Step 13: Whistle Activation Test

First, remove the plug from the relief valve vent.

What you are going to do now is check to see that the warning whistle sounds when it is supposed to sound. Remember, the whistle is designed to alert the wearer when the oxygen in the cylinder is down to 20 to 25 percent of the original cylinder pressure.

Note: 20 to 25 percent of original oxygen cylinder pressure is approximately:

600 PSI for a 3-hour apparatus
700 PSI for a 4-hour apparatus

In testing the warning device, you should first close the oxygen cylinder valve by placing two fingers on the knob, pulling it out, and rotating it clockwise until you meet resistance. Do not overtighten the valve.

Note: Stress the importance of not overtightening the cylinder valve.

Then check the pressure on the chest pressure gauge. It should move towards zero; and the whistle should sound when the needle reads 20 to 25 percent of the full cylinder pressure.

Step 14: Whistle Duration/ Pressure Gauge Shutoff Test

Now that you've tested the whistle to determine when it sounds, you'll want to determine how long it sounds. Remember it should sound for 20 to 60 seconds.

At the same time, you will be testing the pressure gauge shutoff valve to see that it closes properly.

Before you begin this test, switch the tester to negative pressure pumping.

To get the whistle to sound, lift the pressure gauge shutoff lever, open the oxygen cylinder valve (again with two fingers) and start the stopwatch. The whistle should sound for 20 to 60 seconds.

Now check the chest pressure gauge. It should read zero, indicating that the shutoff lever properly closes the line leading to the gauge.

When you're finished with the test, make sure to return the shutoff lever to its original position.

Step 15: High-and Medium-Pressure Leak Test

Now you're finished using the tester and are ready for the final test: testing the high- and medium-pressure lines for leaks if the tester has indicated that a leak exists.

With the cylinder valve still open, coat the high- and medium-pressure lines and connections with a soap lather or a leak detector solution, and look for bubbling of the solution. Where there are bubbles, there is a leak.

There is also another way of testing for high-pressure leaks: Turn on the apparatus and plug the preflush/dosage line with a special plug (R¼"). After the preflush is complete, shut off the cylinder valve and tap on the test gauge with your finger.

After 5 minutes, open the cylinder valve again and observe the test gauge for any noticeable movement of the needle. If the needle jumps up, this would indicate that oxygen leaked out during the 5-minute period.

That concludes the testing. You can now close the cylinder valve, unless you are going directly into training or rescue operations.

Demonstration check: Have each team member perform all 15 apparatus tests. Use copies of the *Demonstration Check 3 Draeger Testing Procedure* form provided at the back of this module to check each team member's performance. Review the results with each team member.

Troubleshooting

Note: If the team members will not be required to make their own repairs on their apparatus, you may omit this section.

"Troubleshooting" means finding out what to do if testing turns up something wrong with the apparatus.

Reference: For more detailed information on troubleshooting the apparatus, refer to the Draeger *Troubleshooting and Maintenance Manual* packed with the apparatus.

The importance of troubleshooting cannot be overemphasized. In an actual mine rescue emergency, your life can depend on how well your apparatus functions. So it is extremely important that your apparatus be in perfect working order and that any problems or malfunctions of the apparatus be discovered and repaired before you wear it.

When you troubleshoot, you test the apparatus, determine where the problem is, and then correct it by making repairs, replacing parts, or in some cases sending a malfunctioning part back to the manufacturer.

In many cases, the trouble may be little more than a loose connection or worn gasket.

A good troubleshooter practices preventative maintenance by being on the lookout for signs of wear in the apparatus that could cause future problems if not corrected.

Visual: Distribute copies of the "Visual 17" handout which is a guide to troubleshooting procedures. You may also use an overhead transparency of this visual as you discuss each procedure with the team.

Note: Because this section discusses the troubleshooting of apparatus malfunctions and repairs, it does not repeat the 15 apparatus tests covered in the previous section. If necessary, refer back to the appropriate test in the previous section as you discuss each troubleshooting procedure. You may also have the team members refer back to their copies of "Visual 16" as each troubleshooting procedure is discussed.

Demonstration: As you discuss each troubleshooting procedure that follows, show the parts on an apparatus that could cause the problem in each test and, if possible, demonstrate how these parts are replaced or corrective procedures done. Have the team members follow your demonstrations by using the "Troubleshooting Procedure" handout ("Visual 17"). You may also refer again to "Visual 2" for a picture of where these various parts are located on the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Exhalation Valve Test

The exhalation valve is designed to let air flow in one direction: away from you (from the facepiece through the exhalation hose) to the canister.

The Exhalation Valve Test checks the exhalation valve to make sure it is letting the breathing air flow only in that one direction. In the test, with the tester set on negative pressure pumping, a properly functioning exhalation valve should not allow air to flow out of the breathing bag. (The bag should not deflate.)

If air does flow out of the breathing bag, the exhalation valve should be thoroughly cleaned to insure no soap or dirt deposits have caused the valve to leak. If this does not correct the problem, the valve should be replaced.

Inhalation Valve Test

The inhalation valve is also designed to let air flow in one direction: from the apparatus toward you (through the inhalation hose and facepiece).

The Inhalation Valve Test checks the inhalation valve to make sure it is letting the breathing air flow only in that one direction. In the test, with the tester set on positive pressure pumping, a properly functioning inhalation valve should not allow air to flow into the breathing bag. (The bag should not inflate.)

If air does flow into the breathing bag, the inhalation valve should be thoroughly cleaned to insure no soap or dirt deposits have caused the valve to leak. If this does not correct the problem, the valve should be replaced.

Relief Valve Test

The pressure relief valve vents the excess air you don't use that the apparatus is providing. It activates if your oxygen consumption is less than 1.4 to 1.7 liters per minute.

The Relief Valve Test checks to see that the pressure relief valve opens when the circuit pressure is between +10 mm H_2O (+1 mbar) and +40 mm H_2O (+4 mbar). In the test, the tester is set on positive pressure pumping. A properly functioning pressure relief valve should open when the breathing bag is full and the pressure is between +10 to +40 mm H_2O (+1 to +4 mbar).

If it does not open within this range, the problem can usually be corrected by replacing the retaining spring in the pressure relief valve. The diaphragm should also be inspected. A leaking diaphragm will create a low opening pressure,while an old diaphragm which has lost its flexibility due to age will create a high opening pressure. A manufacture date is stamped on each diaphragm.

Visual: Point out the retaining spring in the pressure relief valve of the lung demand assembly on an apparatus, and/or refer again to "Visual 10" for a picture of this spring.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Positive Pressure Leak Test

The Positive Pressure Leak Test checks to see that no oxygen leaks out of the apparatus while it is operating. Any such leak can significantly reduce the amount of time you'll have under oxygen.

With the tester set on positive pressure pumping, the pressure relief valve and warning whistle properly sealed off, the circuit pressure pumped to +100 mm H_2O (+10 mbar), and then (after switching the tester to leak test) the pressure bled down to +70 mm H_2O (+7 mbar), an airtight apparatus's pressure should not drop more than 10 mm H_2O (1 mbar) in 60 seconds. A leak can probably be traced to a loose connection or damaged "O" ring or washer.

Visual: Point out these connections on an apparatus, and/or refer to "Visual 18" for a picture of where these connections are located.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

So if there is a leak, first retighten these connections:

1. Hose adapter on the Rz25 tester.
2. Screw ring cover on lung demand valve assembly.
3. Absorbing cartridge connections.
4. Plug on training canister.
5. Breathing bag.
6. Supplementary oxygen line connection at lung demand valve.

7. Preflush line connection.

8. Cylinder connection.

9. Locking screw on saliva trap.

10. Breathing hoses.

11. Test plugs.

12. Cylinder valve.

If, after these connections have been retightened, the positive pressure test still indicates a leak, disconnect the breathing hoses from the apparatus and attach the screw caps.

Then, do the positive pressure leak test on the hoses to determine if the hoses are the leak source. If they are not, remove the breathing bag, cap off the lung demand valve connection of the bag, and connect the canister connection of the bag to the tester. Hold your finger over the dosage line connection on the bag and do a positive pressure leak test on the breathing bag.

If the breathing bag is not leaking, reassemble the apparatus and systematically replace the "O" rings or washers on the following connections in this order. Retest the apparatus after you replace each part.

1. Supplementary valve line.

2. Preflush line connection.

3. Cylinder connection.

4. Plug on training canister.

5. Breathing bag.

6. Screw ring cover on lung demand valve assembly.

7. Canister connection on lung demand valve assembly.

Negative Pressure Leak Test

The Negative Pressure Leak Test checks to see that no outside air or toxic gases enter the breathing circuit while it is operating.

With the tester set on negative pressure pumping, the pressure relief valve plug removed, and the whistle cover in place, the circuit pressure pumped to -100 mm H_2O (-10 mbar), and then (after switching the tester to leak test) the pressure bled up to -70 mm H_2O (-7 mbar), your apparatus's pressure should not rise more than 10 mm H_2O (1 mbar) in 60 seconds if there is no air leaking in.

If the pressure does rise more than 10 mm H_2O (1 mbar), the leak is probably from a loose connection or damaged "O" ring or washer. Also examine the pressure relief diaphragm since this diaphragm was not tested for leaks during the positive pressure test due to the plug in the relief valve cover.

Retighten the same connections tightened in the Positive Pressure Leak Test.

After these connections have been retightened, if the negative pressure test still indicates a leak, test the breathing hoses, breathing bag, or systematically replace the "O" rings or washers on the connections as noted in the Positive Pressure Leak Test.

Visual: Again point out these connections on an apparatus, and/or again refer to "Visual 18" for a picture of where these connections are located.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Preflush Test

The Preflush Test checks to see that the apparatus's automatic preflushing action fills the breathing circuit with oxygen and removes nitrogen as soon as the oxygen cylinder valve is opened.

With the plugs removed from the lung demand valve and warning whistle, the breathing bag fully deflated, the tester set on negative pressure pumping, all connections tightened, and the oxygen cylinder valve opened, the breathing bag should fully inflate and the whistle should make a short chirp if the apparatus is functioning properly.

If the bag does not fully inflate, repeat the test. If it still does not fully inflate, the entire oxygen control group must be replaced by sending it to the manufacturer or their agent.

Also, if the preflushing device fails to close after flushing, the oxygen control group must be replaced.

Failure of the apparatus in the preflush test means that harmful nitrogen has not been purged from the breathing circuit and the apparatus is not fit for use until the oxygen control group has been replaced and this test is successfully completed.

Pressure Gauge Equalization Test

When the oxygen cylinder valve is opened and the breathing circuit is charged with oxygen (this is done in the Preflush Test), the oxygen cylinder pressure gauge and the chest pressure gauge must have the same reading or "equalize" within 10 percent of each other.

If they do not equalize, there could be three things wrong:

Visual: Point out the following gauges and connections on an apparatus, and/or again refer to "Visual 18" for a picture of where these gauges and connections are located.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. The oxygen cylinder pressure gauge is defective. Replace the cylinder and check again for equalization.
2. The chest pressure gauge is defective. To determine which gauge is defective, replace cylinder and check again. If the gauge is now equalized, then the cylinder gauge was defective. In this case the entire cylinder should be returned to the manufacturer or their agent for replacement of the gauge.
3. There is a leak between the oxygen control group and the chest pressure gauge.

To find the leak, apply a soap solution or leak detector to the high pressure connections on the oxygen control group, warning whistle, and the chest pressure gauge line wrench. Tighten any connection leaks or replace the chest pressure gauge line if it is cut. If this procedure shows no leaks or cuts and the gauges still do not equalize, replace the defective gauge.

Lung Demand Valve Test

The Lung Demand Valve Test checks for proper functioning of the lung demand valve that opens to provide more oxygen when your breathing rate increases.

With the tester set on negative pressure pumping, the valve should open between -10 mm H_2O and -40 mm H_2O (-1 mbar to -4 mbar). You should be able to hear the valve open.

If the valve does not open within this pressure range, do these steps:

Visual: Point out these parts on the lung demand assembly of an apparatus, and/or refer again to "Visual 10" for a picture of the parts of the lung demand assembly.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. Remove the cover from the lung demand assembly.
2. Inspect the diaphragm for punctures and tears.
3. Inspect the valve head to see if it is properly seated.
4. Inspect the set bolt to see if it has freedom of movement and valve pin lever is not bent.
5. Inspect valve pin lever to see if it is bent.
6. Replace the retaining spring if all of the above parts are not damaged and function properly.
7. Replace lung demand valve.

Breathing Bag Volume Test

The Breathing Bag Volume Test checks to see that the breathing bag holds a volume of at least 5 liters.

With the breathing bag full and the tester set on negative pressure pumping, it should take at least 10 strokes of the pump to open the lung demand valve.

If the valve opens before 10 strokes, two things could be wrong:

1. The bag was not fully inflated before the test. Pump the bag up until the pressure relief valve opens and repeat the test.

2. The bag is inserted incorrectly or twisted. Check for proper connection of the bag at the lung demand valve assembly and make sure the bag is not twisted at that connection. The Draeger emblem on the bag should face outward.

Bypass Test

The bypass valve, when activated, should fill the breathing bag with oxygen in 10 seconds or less.

If it does not, the bypass assembly is malfunctioning. The oxygen control group should be replaced and the malfunctioning oxygen control group returned to the manufacturer for repairs.

Constant Dosage Test

The Constant Dosage Test checks to see that the oxygen control group provides a constant flow of oxygen into the breathing bag at a rate of approximately 1.5 liters per minute (LPM).

As you recall, the pressure reducer in the oxygen control group reduces the pressure of the oxygen from the cylinder down to 57 PSI. Oxygen at this pressure of 57 PSI then flows through the dosage metering orifice at a constant flow of approximately 1.5 LPM to the breathing bag.

With the breathing bag fully deflated, the tester set on red dosage (0.5 to 2 LPM), and the pressure relief valve cover plugged, activate the bypass valve and listen for oxygen flowing into the breathing circuit as the breathing bag inflates. When the needle on the tester gauge reaches 1.7 LPM (on the outside red scale), release the bypass button.

If the apparatus is functioning properly, the dosage should settle between 1.4 and 1.7 LPM. (Be sure to remove the pressure relief valve cover plug after the test is completed.)

If the dosage does not fall between 1.4 and 1.7 LPM, you must first check to see that the oxygen control group is functioning properly.

Note: The permissible dosage range (1.4 to 1.7 LPM) will increase at higher elevations. For example, at 6,000 feet the permissible range is 1.5 to 1.8 LPM.

Visual: Point out these parts on an apparatus, and/or refer again to "Visual 18" for a picture of the location of these parts.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. Remove the preflush line from the cartridge connection socket.
2. Remove the breathing hoses and the hose adapter from the tester.
3. Connect the preflush line to the tester using the small diameter hose provided with the tester. Be sure the apparatus is on and preflushing is completed before attaching the hose.
4. Check the dosage reading on the tester gauge. If it reads between 1.4 and 1.7 LPM, the oxygen control group is functioning properly.

If it does not read between 1.4 and 1.7 LPM, the oxygen control group must be replaced. The defective unit must be returned to the manufacturer or their agent for repair.

If the oxygen control group checks out, you can now troubleshoot for the cause of the improper dosage reading.

If your reading for the constant dosage test was less than 1.4 LPM, you have low dosage. This can be caused by a leak in the breathing system.

Make sure all hand-tight connections are secure (including those that connect the apparatus to the tester).

If these are secure, the cause for a low dosage reading can usually be traced to a damaged or worn "O" ring or washer. Systematically replace these using the same procedure you used in the Positive Pressure Leak Test.

If your reading for the constant dosage test was more than 1.7 LPM, you have high dosage.

High dosage usually means a leak in the valve head of the lung demand assembly. (This is an internal leak not detectable in the Positive and Negative Pressure Leak Tests.)

Visual: Point out these parts on the lung demand assembly of an apparatus, and/or refer again to "Visual 10" for a picture of the lung demand assembly.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. Close the cylinder valve and wait until the chest gauge reads zero pressure. Lift the pressure gauge shutoff lever, and open the cylinder valve (ignore the sounding of whistle which will stop in 20 to 60 seconds). Reconnect preflush line to tester with small hose and read dosage.

   If dosage is now okay, the problem was caused by high pressure oxygen at whistle connection leaking into the medium pressure line and then back into the oxygen control group, causing high dosage. Replace whistle and return defective unit to manufacturer.

   Close cylinder valve and return pressure shutoff lever to original position.

2. If high dosage still exists, remove the cover from the lung demand assembly and inspect the demand valve for leaks. Leakage can be determined by applying a leak detection or soap solution to the demand valve (with the cylinder valve open).

   If a leak is found, remove the demand valve and replace the tin washer with the spare washer provided in the tool kit. If this does not correct the leak, replace the lung demand valve.

Whistle Activation Test

The Whistle Activation Test checks to see that the warning whistle sounds when the oxygen cylinder pressure drops to about 20 percent to 25 percent of its original pressure.

With the oxygen cylinder valve closed, the whistle should sound at about 700 PSI on a four hour apparatus and 600 PSI on a three hour apparatus. Look at the chest pressure gauge for these readings.

If the whistle does not sound at these readings, it should be returned to the manufacturer or their agent for repair.

Whistle Duration/Pressure Gauge Shutoff Test

The Whistle Duration/Pressure Gauge Shutoff Test checks to see that the warning whistle sounds for 20 to 60 seconds before sealing itself, and that the manual chest pressure gauge shutoff lever isolates the chest pressure gauge and line if a leak develops in the gauge or the line.

With the tester set on negative pressure pumping, the pressure gauge shutoff lever lifted, and the oxygen cylinder valve opened, the warning whistle should sound for 20 to 60 seconds (from when the cylinder was opened) and the chest pressure gauge should read zero.

If the whistle sounds less than 20 seconds, it is not giving you adequate warning. If it sounds more than 60 seconds, it is wasting oxygen. In either case, it should be replaced and the faulty whistle returned to the manufacturer for repair.

If the chest pressure gauge does show a reading (it does not read zero), the shutoff valve is not completely closed.

Visual: Point out the shutoff lever and the valve screw on the oxygen control group of an apparatus, and/or refer again to "Visual 18" for a picture of these parts.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. Remove the screw on the shutoff lever.

2. Tighten the valve screw in a counterclockwise direction. Reposition the shutoff lever on the valve screw to make the adjustment.

3. Position the valve screw so that the chest pressure gauge line is isolated when the shutoff lever is lifted to a 30^{o} to 45^{o} angle.

   If the test is repeated and the gauge still gives a reading other than zero, replace the oxygen control group and return the faulty unit to the manufacturer or their agent for repair.

High- and Medium- Pressure Leak Test

High- and medium-pressure lines can be tested for leaks any time the apparatus is pressurized. Simply coat the lines and connections with a soap or leak detecting solution.

If, after applying the solution, bubbles appear, slowly tighten the connection by hand or wrench, whichever is required, until no further leaking occurs.

Another way to test for high-pressure leaks is to turn on the apparatus and plug the preflush/dosage line with a special plug (R¼"). After the preflush is complete, shut off the cylinder valve and tap on the test gauge with your finger.

After 5 minutes, open the cylinder valve again and observe the test gauge for any noticeable movement of the needle. If the needle jumps up, this would indicate that oxygen leaked out during the 5-minute period.

When you tighten connections, be sure you do not overtighten. When hand-tightening connections, use two fingers. When wrench-tightening connections, use two fingers on the wrench.

If, after tightening, the connection still leaks, disconnect the connection and replace the proper "O" ring or gasket of the complete assembly (i.e., the medium-pressure line) if necessary.

Retighten the connection and check once more to see that it does not leak.

Finally, remember to shut off the oxygen cylinder after the test.

Periodic Maintenance

__Visual__: Distribute copies of the "Visual 19" handout which is a listing of the Draeger's periodic maintenance. You may also use an overhead transparency or chalkboard sketch to refer to as you discuss these items with the team.

__Reference__: For more detailed information on the apparatus, refer to the Draeger *Troubleshooting and Maintenance Manual* packed with the apparatus.

In addition to routine scheduled maintenance, replacement of certain parts of the apparatus is required at various intervals.

The following parts are listed under their maximum service life times. This means that you should service or replace these parts at or before the time given–never after. Naturally, if a part is damaged or wears out before its service life is up, it should be replaced.

If accurate maintenance records are kept on each apparatus, you shouldn't have much trouble determining when parts should be serviced or replaced.

After each use:

1. Condition the leather wiper in the ZS facepiece with a suitable antifog solution after cleaning.

Note: Remember not to use antifog solutions containing alcohol.

2. Any time a copper gasket is removed from the apparatus for whatever reason, it should be replaced with a new copper gasket to insure proper sealing. Do not reuse old copper gaskets.

3. When cleaning, inspect the breathing bag, breathing hoses, and facepiece for stiffness, cracking, and signs of aging.

4. When cleaning, inspect the lung demand diaphragm for damage and aging.

Every 6 months:

5. Replace the "O" ring at the oxygen cylinder connection.

Every 2 years:

6. Replace all rubber or Neoprene sealing rings.

Panorama ZS and ZST note: Replace all rubber or Neoprene sealing rings in the wiper mechanism of the ZS and ZST facepieces.

7. Put a new inhalation valve into the lung demand assembly.

Every 3 years:

8. Replace the lung demand diaphragm.

9. Discard spare rubber gaskets and sealing rings. Replace with new parts.

Every 5 years:

10. The oxygen control group should be returned to the manufacturer or their agent for overhaul.

11. The oxygen cylinder must be retested by a certified testing facility. (The test date, in month and year, is stamped on the cylinder, as well as a new "+" sign if the cylinder is "+" rated when retested.)

12. The breathing bag, breathing hoses, and facepiece have a minimum service life of five years. If these items are still in good condition, they need not be replaced.

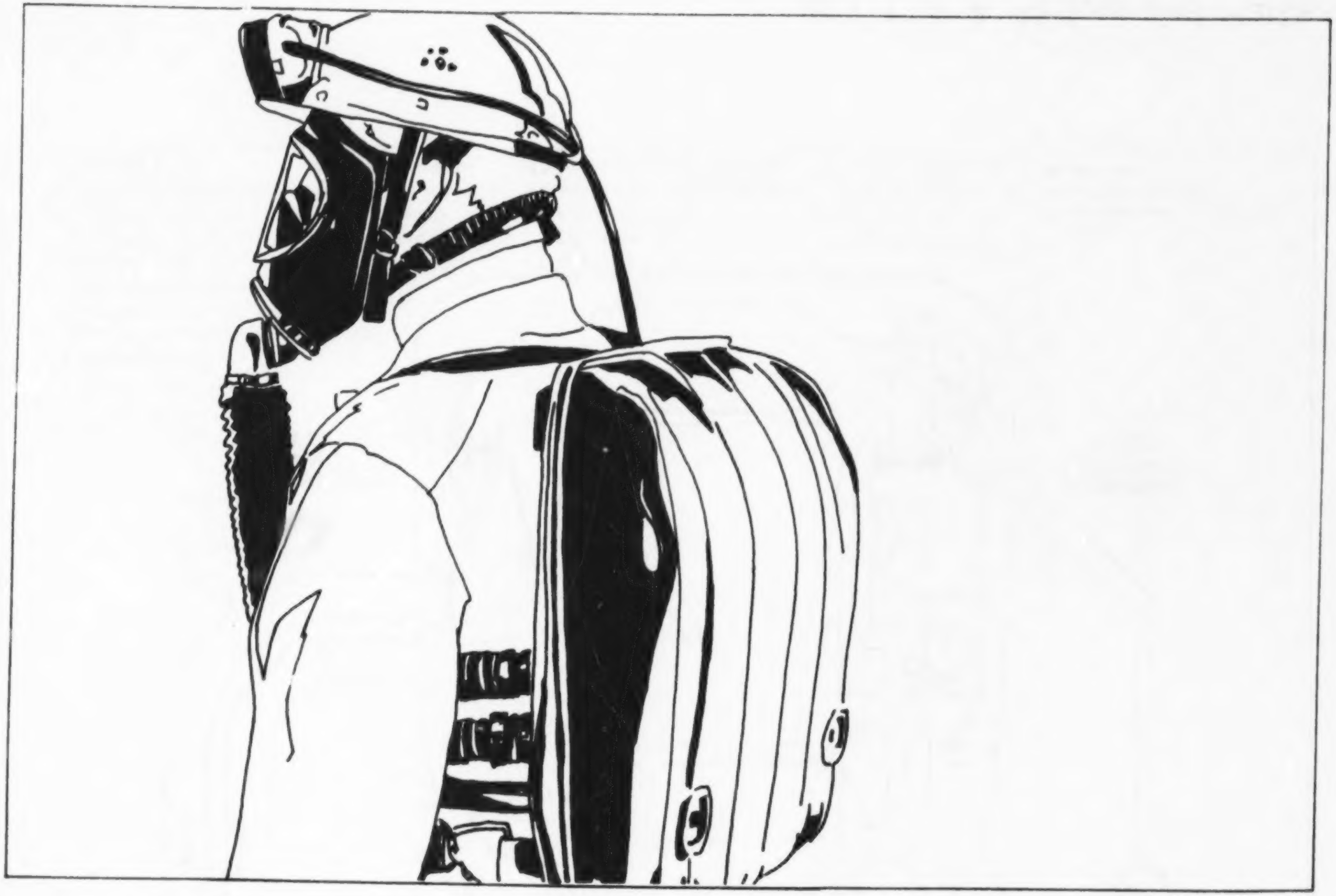
13. The "O" ring under the speaking diaphragm should be replaced. If the diaphragm appears worn, it also can be replaced at this time.

Note: When lens, complete wiper assembly, or speaking diaphragm is changed in the facepiece, the mask should be tested for leaks after reassembly, with the Draeger Mask Tightness Tester.

Every 6 years:

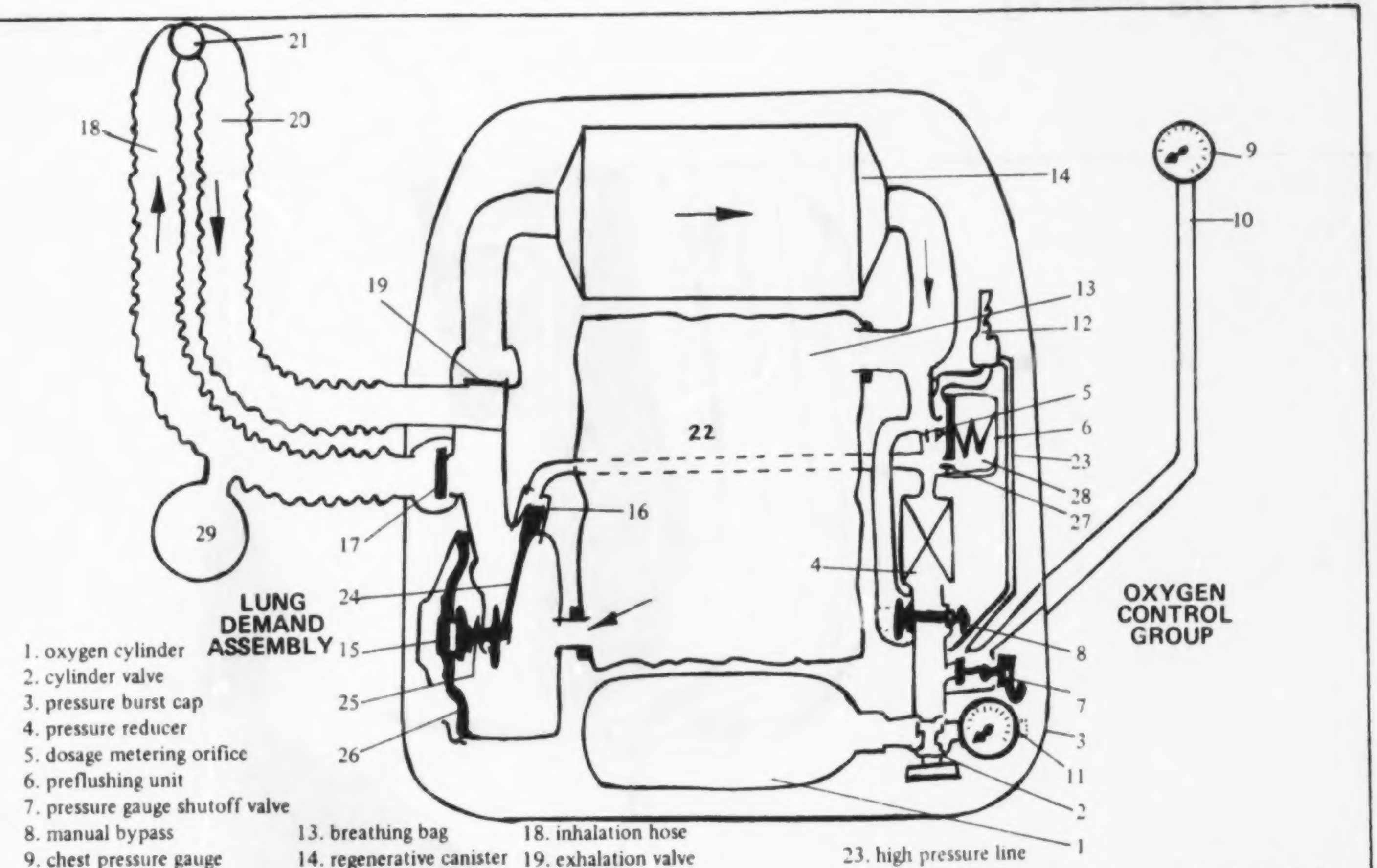
14. The lung demand valve should be replaced.

15. The warning whistle should be returned to the manufacturer or their agent for overhaul.



Visual 1

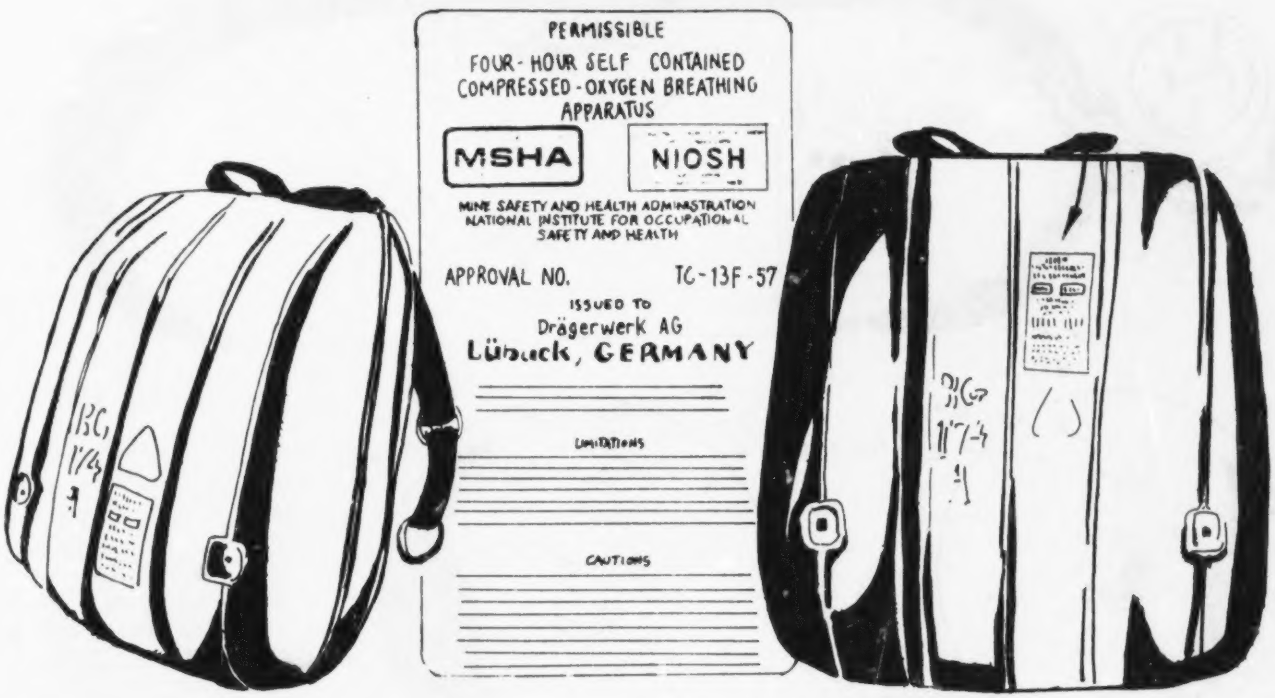
Draeger BG 174-A


21
18
20
19
14
9
10
13
12
22
5
6
23
28
27
16
17
29
4
24
LUNG DEMAND ASSEMBLY
15
25
26
8
7
3
11
2
1
OXYGEN CONTROL GROUP

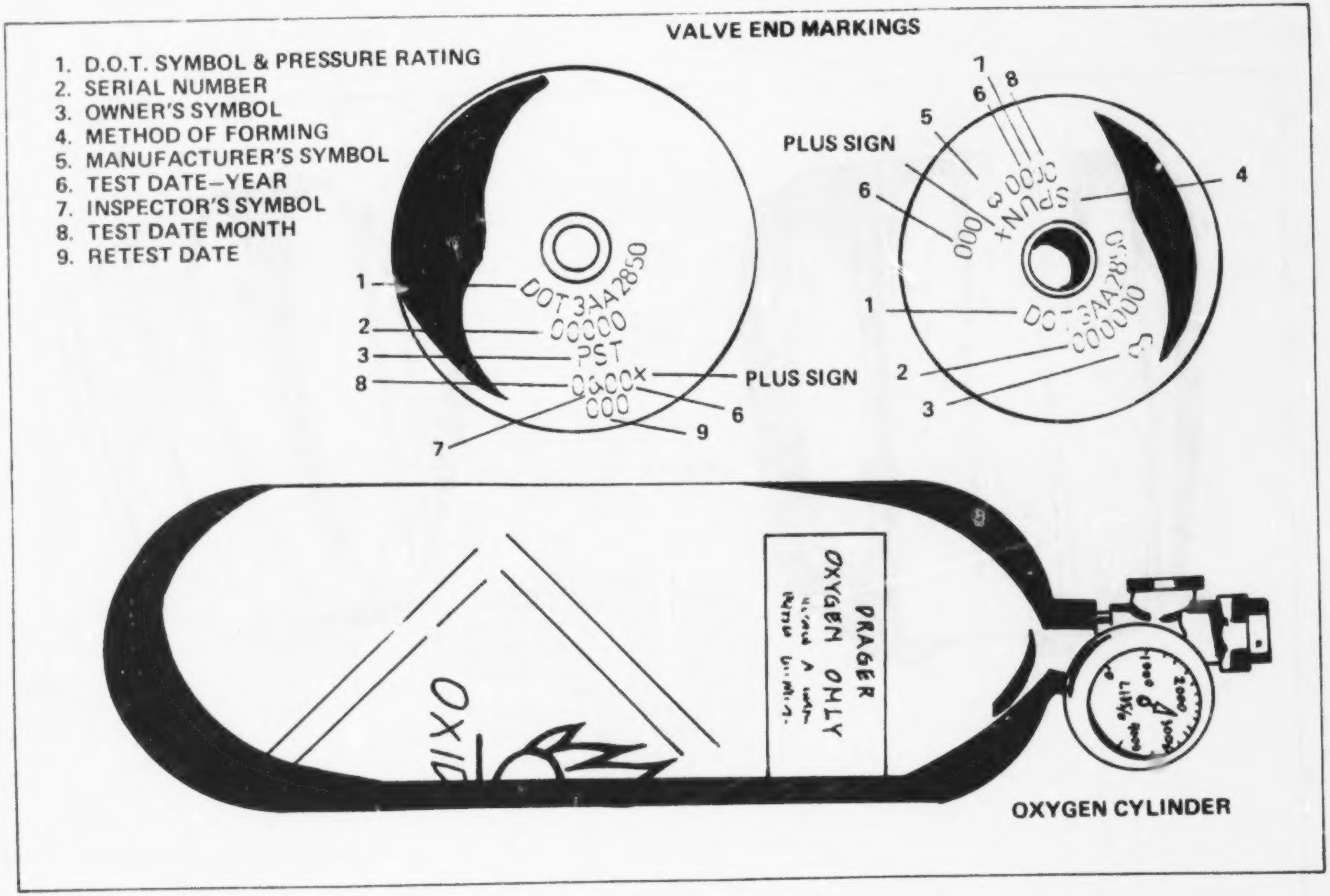
1. oxygen cylinder
2. cylinder valve
3. pressure burst cap
4. pressure reducer
5. dosage metering orifice
6. preflushing unit
7. pressure gauge shutoff valve
8. manual bypass
9. chest pressure gauge
10. pressure gauge line
11. cylinder pressure gauge
12. warning whistle
13. breathing bag
14. regenerative canister
15. pressure relief valve
16. lung demand valve
17. inhalation valve
18. inhalation hose
19. exhalation valve
20. exhalation hose
21. connecting socket for facepiece
22. medium pressure oxygen line
23. high pressure line
24. demand valve lever
25. pin with sealing bolt
26. control diaphragm
27. metering orifice, preflush
28. preflush chamber
29. saliva trap

Visual 2

BG 174-A Airflow and Parts

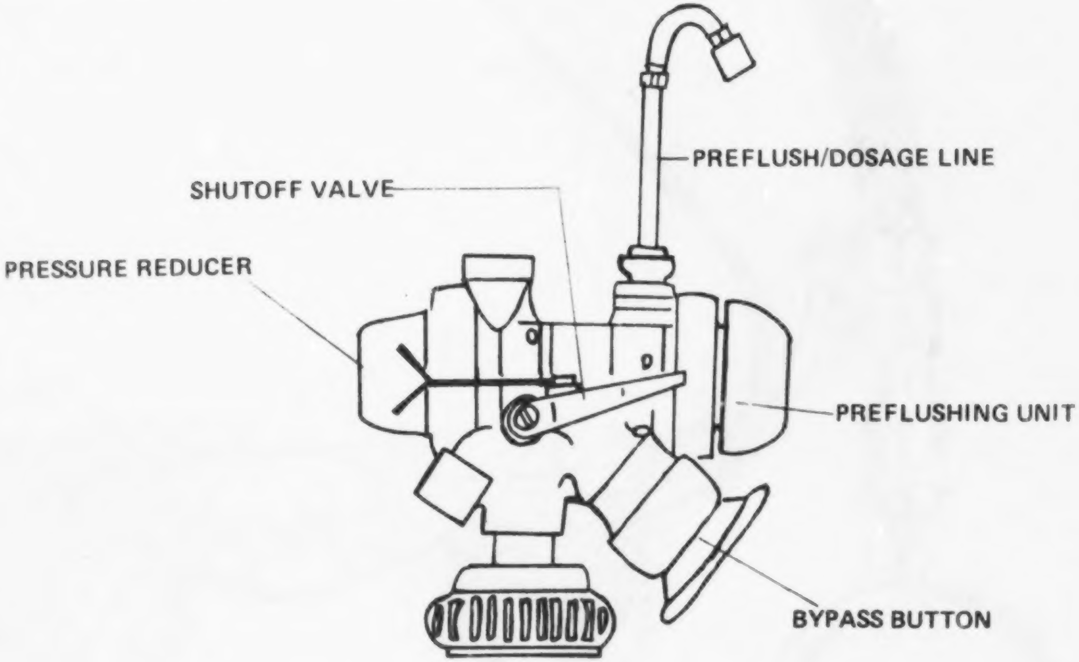

PERMISSIBLE
FOUR-HOUR SELF CONTAINED COMPRESSED-OXYGEN BREATHING APPARATUS
MSHA
NIOSH
MINE SAFETY AND HEALTH ADMINISTRATION
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
APPROVAL NO. TC-13F-57
ISSUED TO
Drägerwerk AG
Lübeck, GERMANY
LIMITATIONS
CAUTIONS
BG 174

Visual 3 Cover

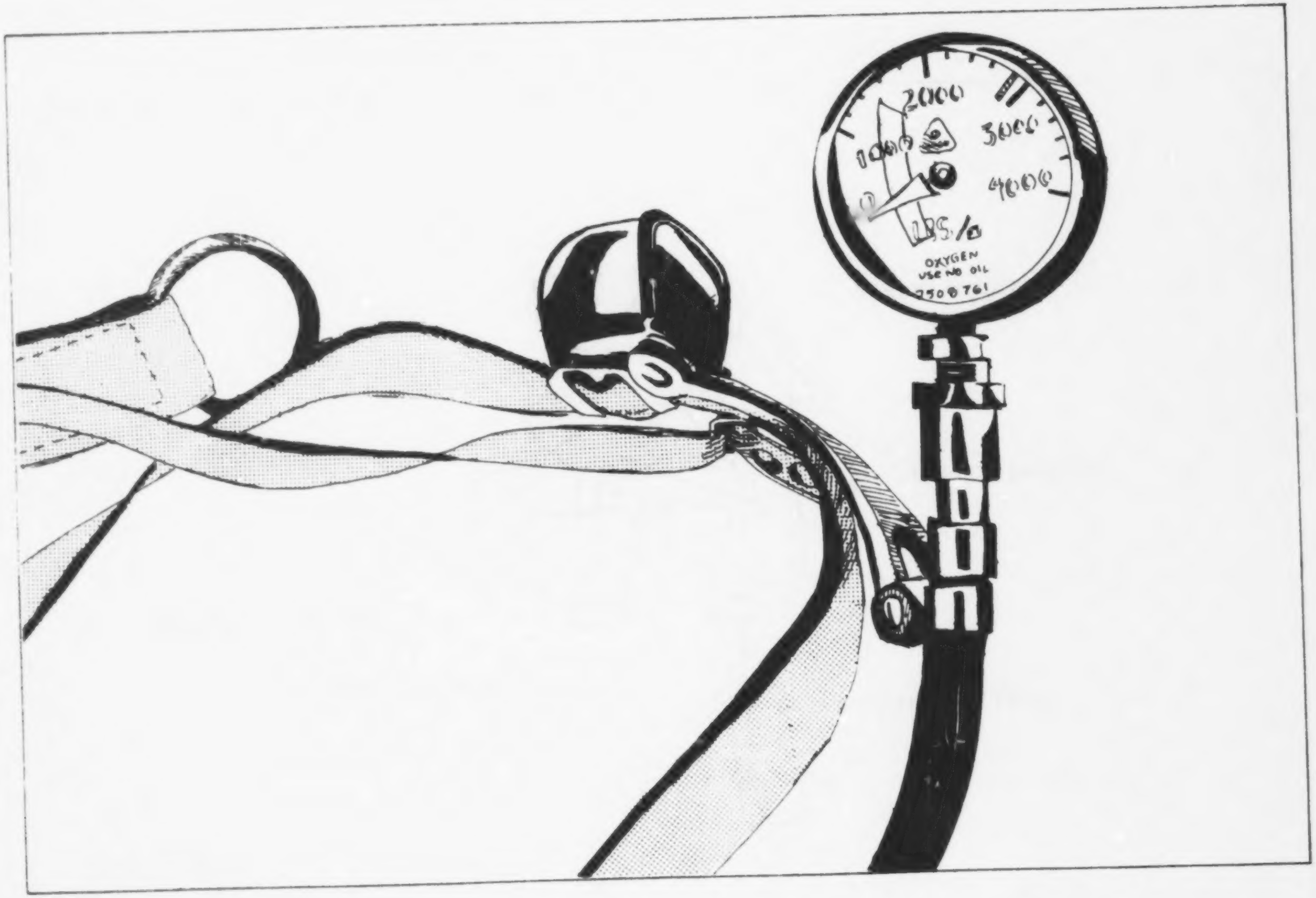

VALVE END MARKINGS
DOT3AA2850
00000
PST
0600X
000
PLUS SIGN
SPUN+
DOT3AA2850
000000
1
2
3
4
5
6
7
8
9
DRAGER
OXYGEN ONLY
OXID
2000
3000
1000
4000
LITS/o
OXYGEN CYLINDER

1. D.O.T. SYMBOL & PRESSURE RATING
2. SERIAL NUMBER
3. OWNER'S SYMBOL
4. METHOD OF FORMING
5. MANUFACTURER'S SYMBOL
6. TEST DATE–YEAR
7. INSPECTOR'S SYMBOL
8. TEST DATE MONTH
9. RETEST DATE

Visual 4 Oxygen Cylinder

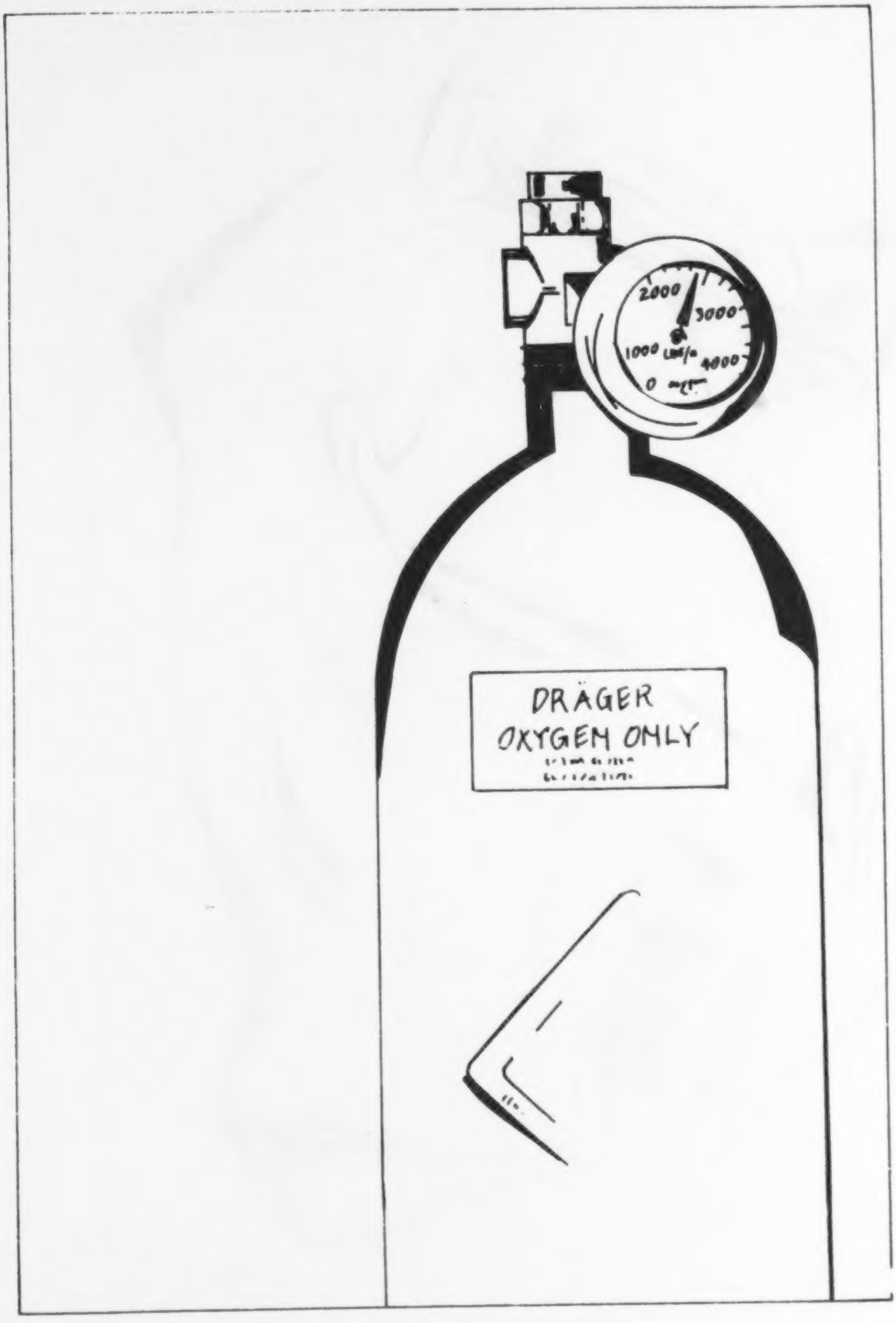

PREFLUSH/DOSAGE LINE
SHUTOFF VALVE
PRESSURE REDUCER
PREFLUSHING UNIT
BYPASS BUTTON

Visual 5 Oxygen Control Group (BG 174-A)


0
1000
2000
3000
4000
LBS/□
OXYGEN
USE NO OIL
2508761

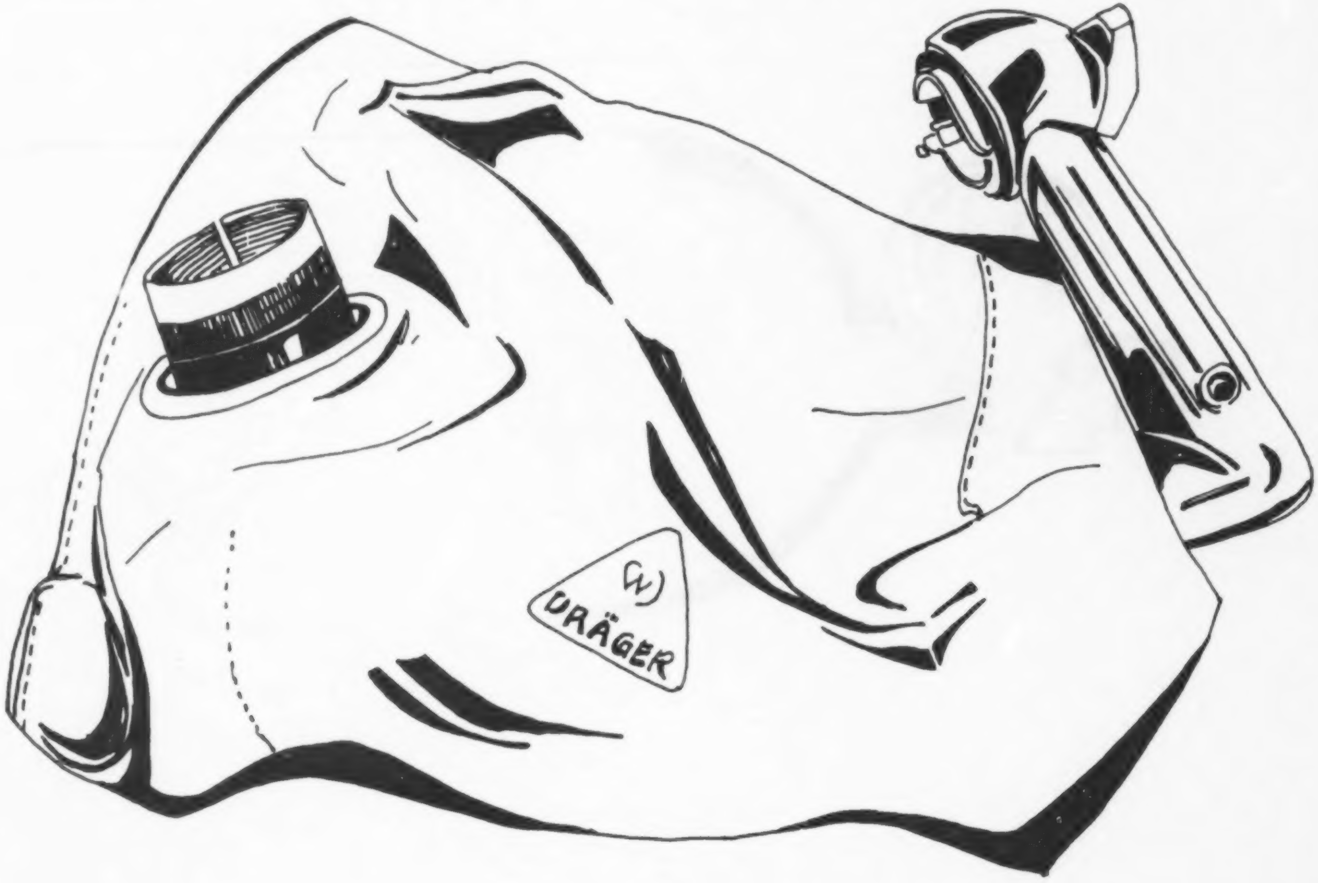
Visual 6

Chest Pressure Gauge

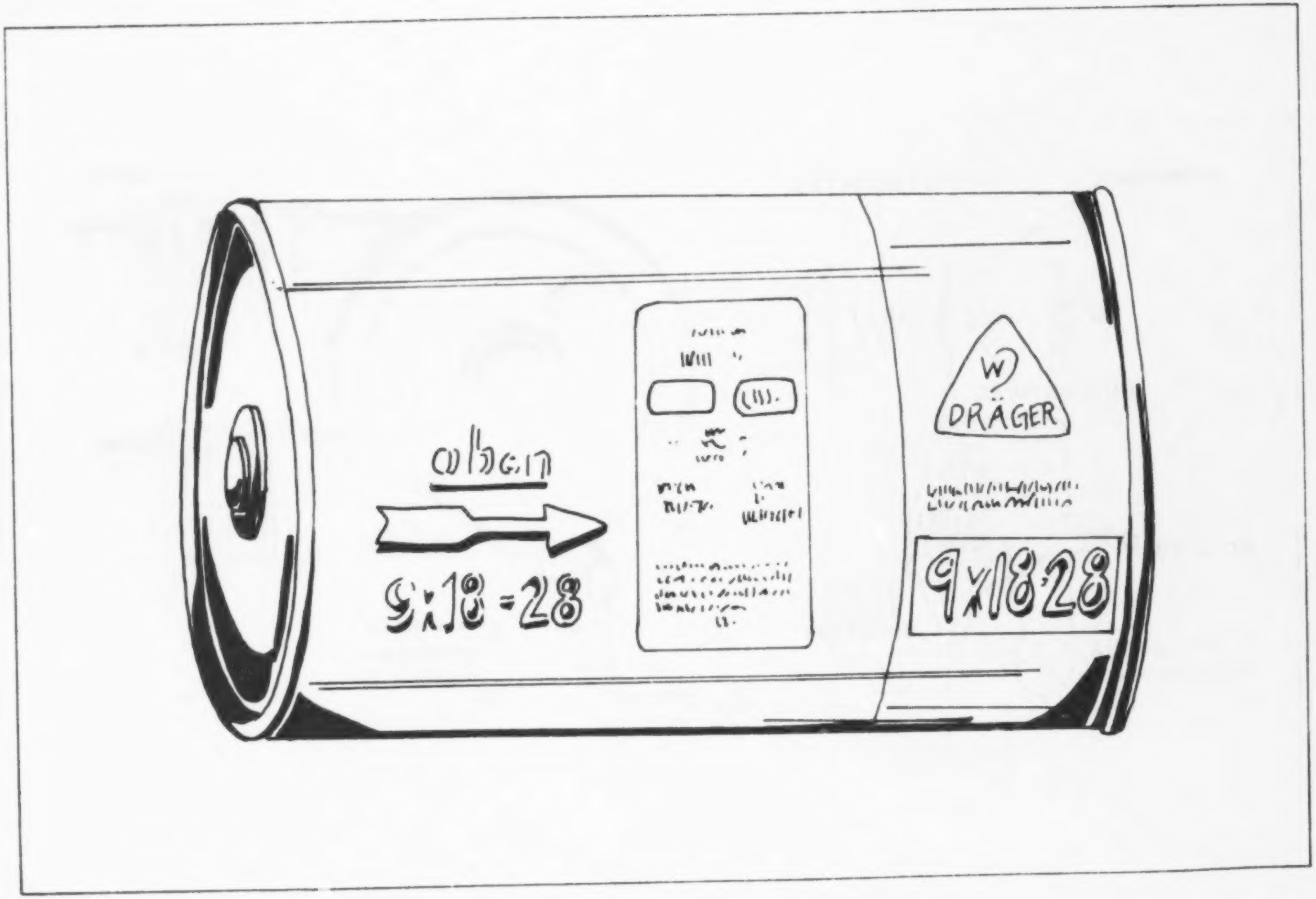

2000
3000
1000
4000
0
Lbs/in
DRÄGER
OXYGEN ONLY

Visual 7

Cylinder Pressure Gauge

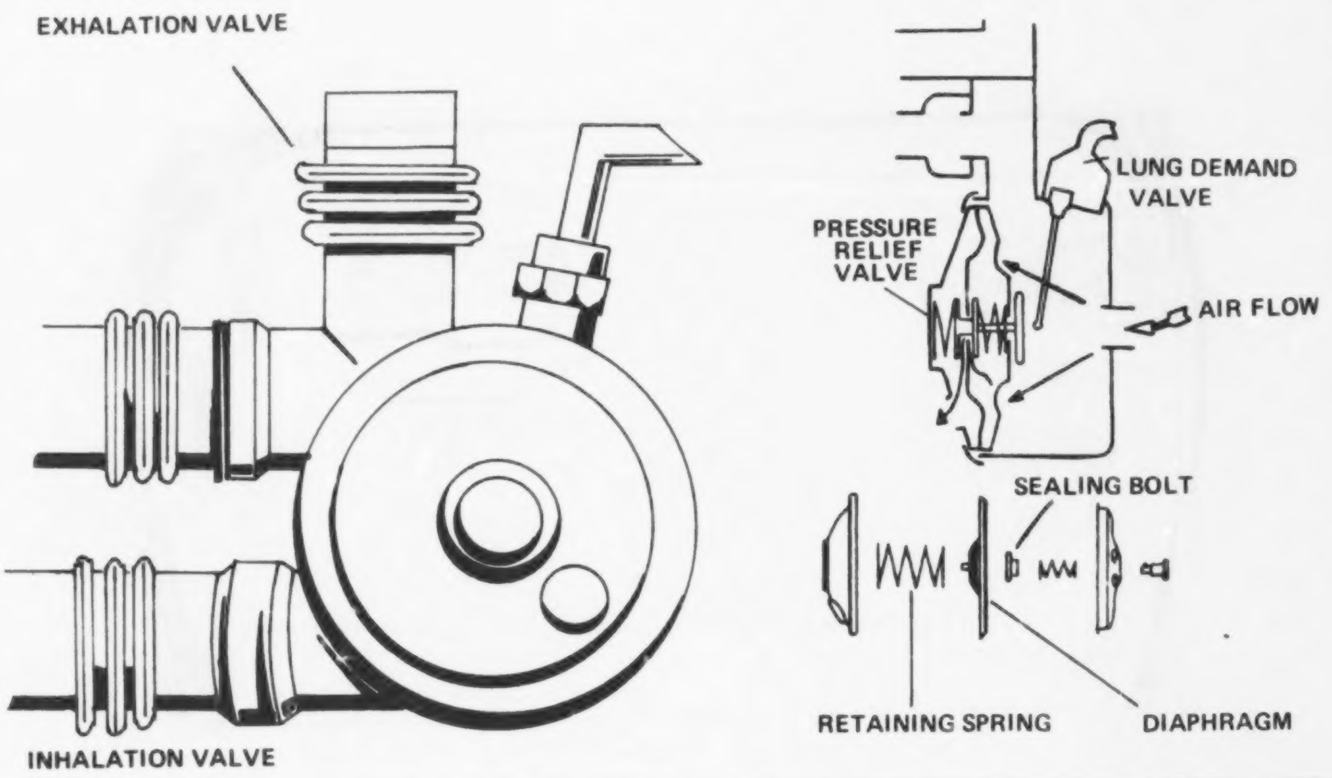


Visual 8 Breathing Bag

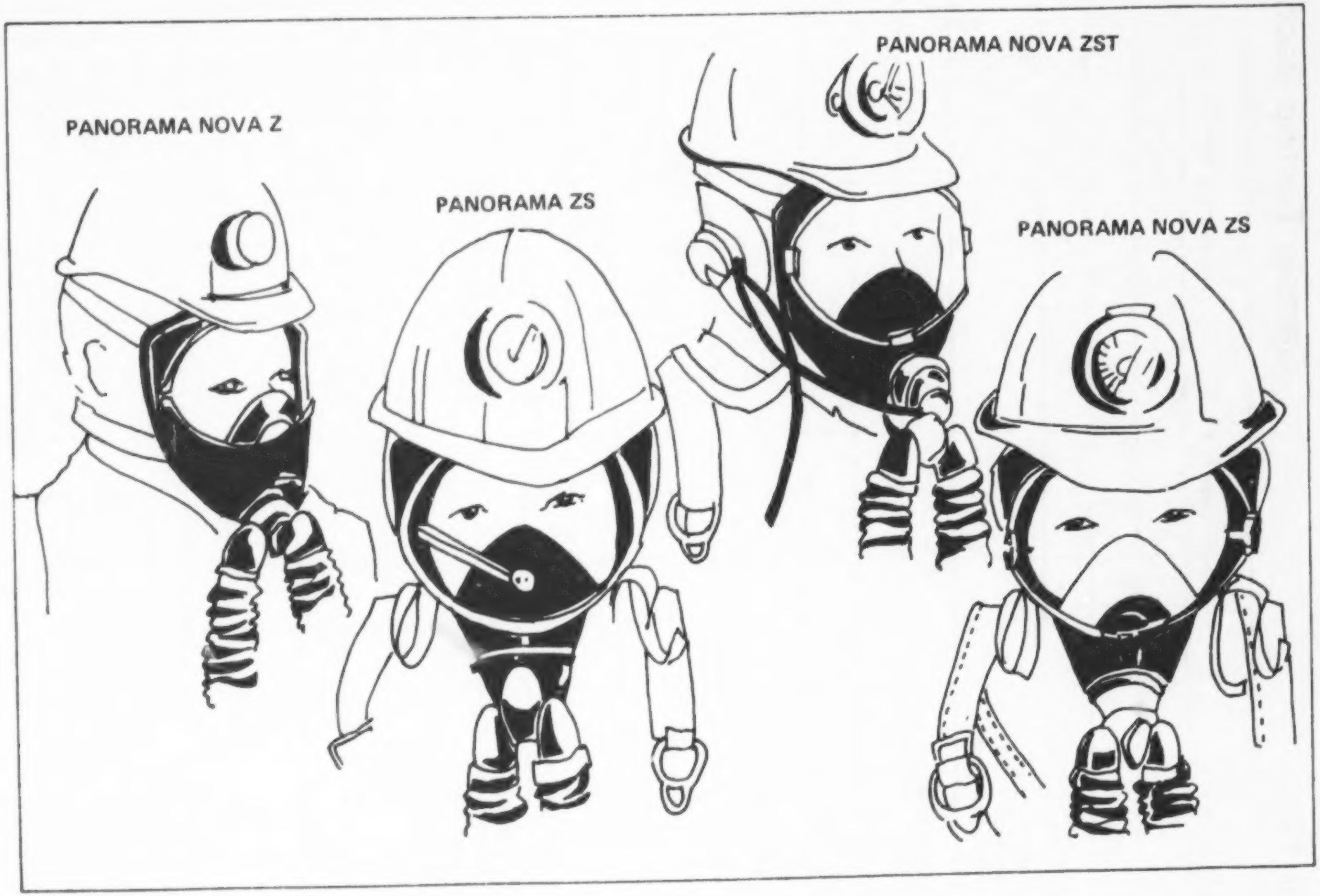

DRÄGER
9x18 = 28
9x1828

Visual 9

Regenerative Canister


EXHALATION VALVE
INHALATION VALVE
LUNG DEMAND VALVE
PRESSURE RELIEF VALVE
AIR FLOW
SEALING BOLT
RETAINING SPRING
DIAPHRAGM

Visual 10 Lung Demand Assembly


PANORAMA NOVA Z
PANORAMA ZS
PANORAMA NOVA ZST
PANORAMA NOVA ZS

Visual 11 Facepieces

Visual 12

Sample Testing Record

Apparatus Serial #	O_2 Control Assembly #					Demand Valve Assembly #					
Test Date											
Visual Inspection											
Cylinder Pressure											
Regenerative Canister Refillable filled? Fact. sealed? Exp?											
Facepiece and Hoses											
Exhalation Valve											
Inhalation Valve											
Relief Valve Opens +10 to +40 mm (or +1 to +4 mbar)											
Pos. Pres. Leak Test											
Neg. Pres. Leak Test											
Preflush											
Gauge Equalization											
Breathing Bag Volume Test											
Lung Demand Valve Opens -10 to -40 mm (or -1 to -4 mbar)											
Bypass											
Dosage Test 1.4 to 1.7 LPM											
Whistle Activation											
Whistle Duration 20 to 60 seconds											
Pres. Gauge Shutoff											
High- & Med- Pres. Leaks											
Test OK (initials)											
Replacement Parts											

Visual 13

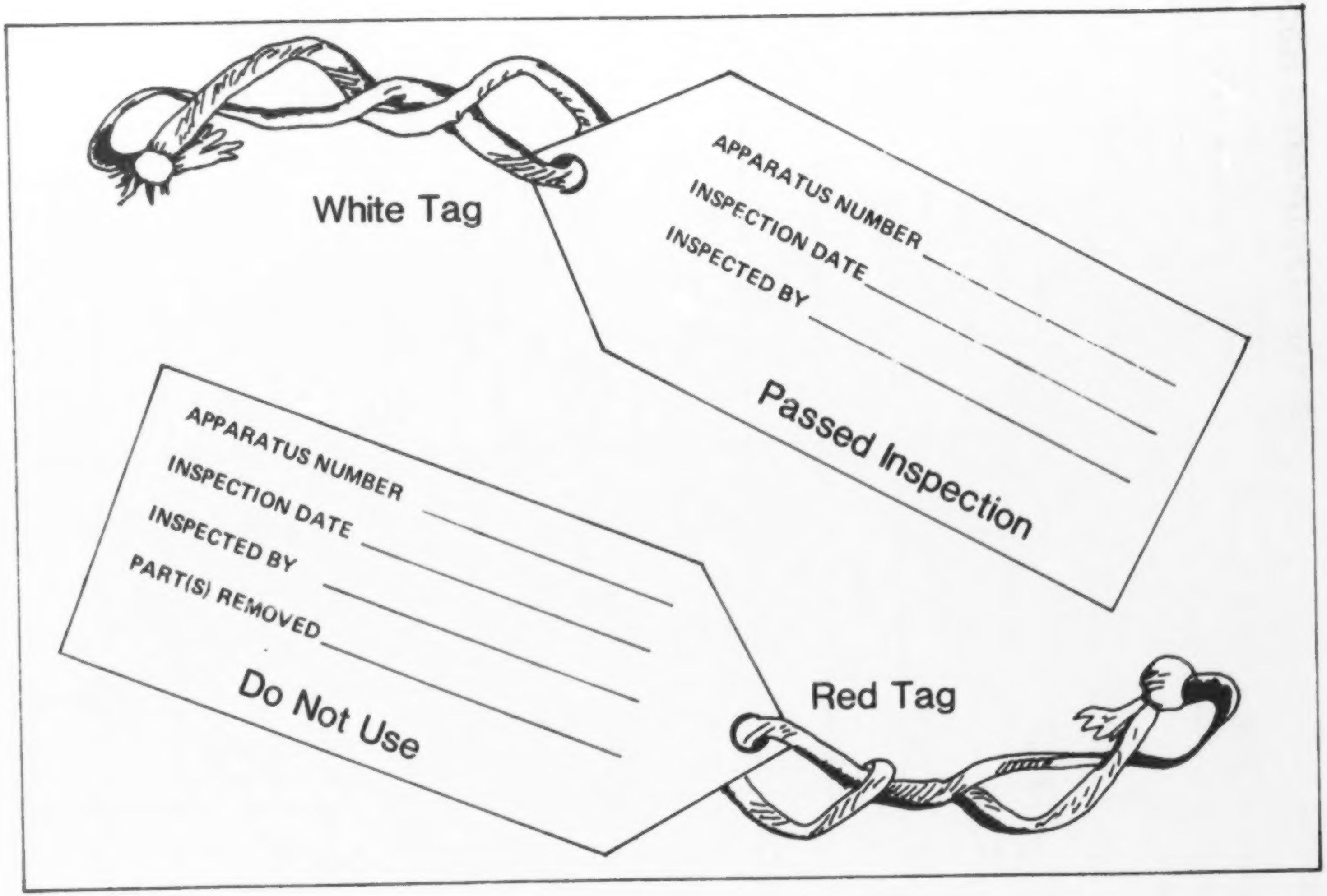
Sample Maintenance Record

Apparatus Type Drager BG 174 A **Serial #** 1234567

Apparatus # 3

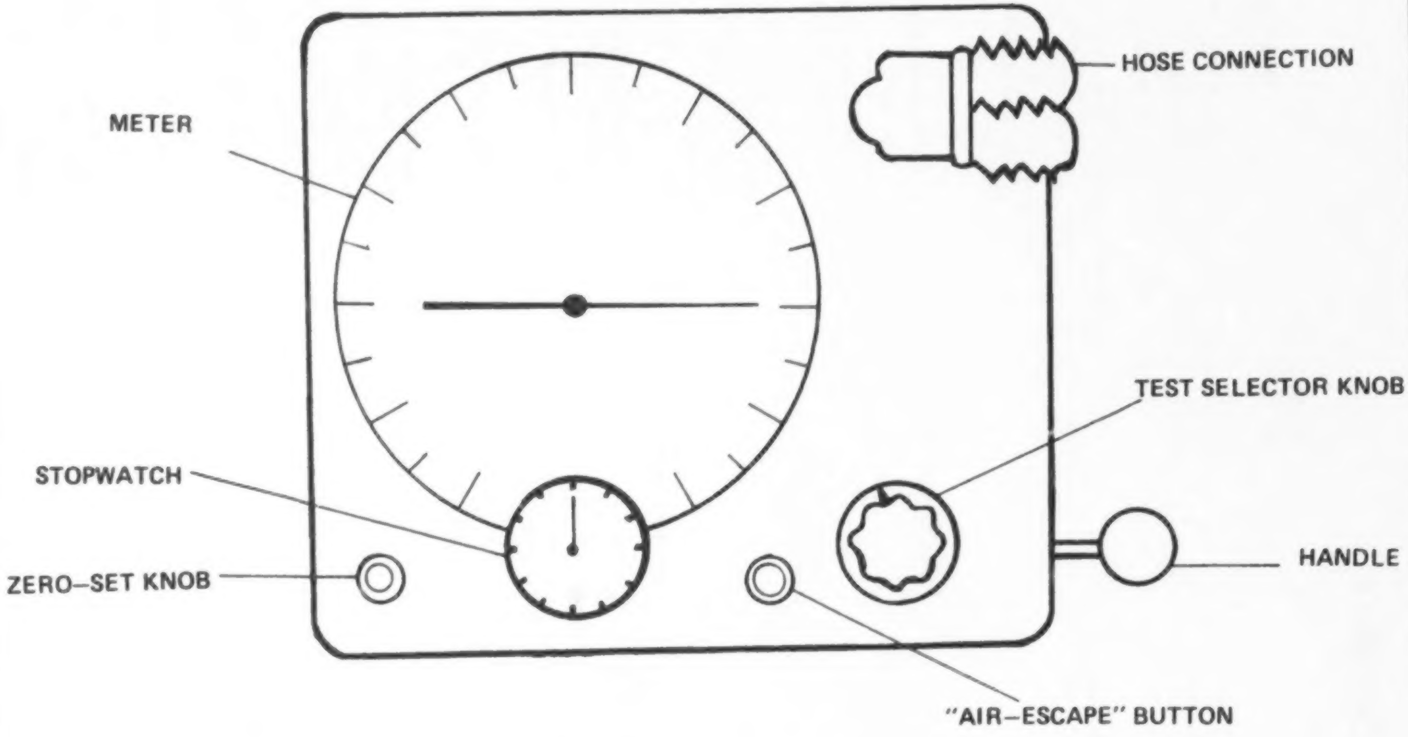
Purchase date 9/21/1978

# Hours Used	Total Hours Used	Date Inspected	Parts Repaired or Replaced	Comments	Inspected By
2	2	9/30/78	none	—	RKS
3	5	10/18/78	none	—	RKS
2½	7½	11/6/78	none	—	RKS
3	10½	12/17/78	replaced O ring at O2 cylinder	—	RKS
3½	14	1/19/79	None	—	RKS
2	16	2/27/79	replaced warning whistle	defective whistle sent out for repair	RKS
3	19	3/17/79	replaced line pressure gauge	gauge cover broken during use	RKS
2	21	3/31/79	None	—	RKS
4	25	4/28/79	None.	—	RKS
4	29	5/30/79	replaced inside hose	hose torn	RKS


White Tag
APPARATUS NUMBER
INSPECTION DATE
INSPECTED BY
Passed Inspection
APPARATUS NUMBER
INSPECTION DATE
INSPECTED BY
PART(S) REMOVED
Do Not Use
Red Tag

Visual 14

Sample Tags


METER
HOSE CONNECTION
TEST SELECTOR KNOB
STOPWATCH
HANDLE
ZERO–SET KNOB
"AIR–ESCAPE" BUTTON

Visual 15

Universal Rz25 Tester

Visual 16
Testing Procedure

STEP	TESTER SETTING	PROCEDURE HINTS
1. Visual Inspection		Check for good condition.
2. Insert O_2 Cylinder		Fully charged.
3. Insert Regen. Canister		Factory-sealed for rescue/refillable for training.
4. Facepiece & Hoses		Check for good condition.
5. Exhalation Valve	Zero-Adjust →	Cap off exhalation hose. Connect inhalation hose to exhalation valve.
	Neg. Pres. Pumping →	Bag should not begin to deflate after 5 seconds.
6. Inhalation Valve		Connect inhalation hose to inhalation valve (saliva trap should be vertical).
	Pos. Pres. Pumping	Bag should not begin to inflate after 5 seconds.
7. Relief Valve		Connect exhalation hose to exhalation valve.
	Pos. Pres. Pumping →	
Alternate Relief Valve Test (Performed after Step 10)		Fill bag. Relief valve should open between +10 and +40 mm H_2O (+1 and +4 mbar).
8. Pos. Pres. Leak		Plug relief valve and whistle.
	Pos. Pres. Pumping →	Pump up to +100 mm H_2O (+10 mbar).
	Leak Test →	Bleed needle down to +70 mm H_2O (+7 mbar). Start stopwatch, observe meter for 60 seconds. Should not drop more than 10 mm H_2O (1 mbar).
9. Neg. Pres. Leak		Remove plug from relief valve only.
	Neg. Pres. Pumping →	Pump down to -100 mm H_2O (-1 mbar).
	Leak Test →	Bleed needle up to -70 mm H_2O (-7 mbar). Start stopwatch, observe meter for 60 seconds. Should not drop more than 10 mm H_2O (1 mbar).

HANDOUT

Visual 16

STEP	TESTER SETTING	PROCEDURE HINTS
10. Preflush/Pres. Gauge Equalization		Remove plug from whistle.
	Neg. Pres. Pumping →	Open O_2 cylinder valve. Bag should completely inflate. Compare gauge readings.
Alternate Relief Valve Test	Neg. Pres. Pumping and Leak Test →	Open cylinder valve. Relief valve should open between +10 and +40 mm H_2O (+1 and +4 mbar).
11. Lung Demand Valve/ Breathing Bag Volume	Neg. Pres. Pumping →	Pump and count strokes. Should be at least 10 strokes before demand valve opens. Valve should open between -10 and -40 mm H_2O (-1 and -4 mbar).
12. Bypass/Constant Dosage	Red Dosage Test (0.5 to 2 LPM) →	Plug relief valve vent. Press bypass valve until needle reads 1.7 LPM on outside red scale. Needle should settle between 1.4 and 1.7 LPM (at sea level).
13. Whistle Activation		Remove plug from relief valve vent. Close O_2 cylinder valve. Observe chest gauge. Whistle should sound at 20 to 25 percent of full cylinder pressure.
14. Whistle Duration/Pres. Gauge Shutoff	Neg. Pres. Pumping →	Lift pressure gauge shutoff lever. Open O_2 cylinder valve. Start stopwatch. Whistle should sound for 20 to 60 seconds. Chest pressure gauge should read zero. Return shutoff valve to down position.
15. High & Med. Pres. Leak		Cylinder valve still open. Check for leaks. Shut off valve after test.

Visual 17

Troubleshooting Procedures

TEST	PROBLEM	WHAT TO DO
1. Exhalation Valve Test (Test 5)	Exhalation valve lets air out of the breathing bag.	Clean exhalation valve. If air still flows out of bag, replace exhalation valve.
2. Inhalation Valve Test (Test 6)	Inhalation valve lets air enter the breathing bag.	Clean inhalation valve. If air still flows into bag, replace inhalation valve.
3. Relief Valve Test (Test 7)	Pressure relief valve does not open when circuit pressure is between +10 mm H_2O (+1 mbar) and +40 mm H_2O (+4 mbar).	Replace retaining spring in pressure relief valve. Replace diaphragm.
4. Positive Pressure Leak Test (Test 8)	Circuit pressure drops more than 10 mm H_2O (1 mbar) in 60 seconds. Leak in apparatus.	Retighten: 1) Hose adapter on the Rz25 tester 2) Screw ring cover on lung demand valve assembly 3) Absorbing cartridge connections 4) Plug on training canister 5) Breathing bag 6) Supplementary oxygen line connection at lung demand valve 7) Preflush line connection 8) Cylinder connection 9) Locking screw on saliva trap 10) Breathing hoses 11) Test plugs 12) Cylinder valve If leak persists, do a positive pressure leak test on the breathing hoses and, if necessary, the breathing bag. If leak is still not located, replace "O" rings/washers in order on these connections: 1) Supplementary valve line 2) Preflush line connection 3) Cylinder connection 4) Plug on training canister 5) Breathing bag 6) Screw ring cover on lung demand valve assembly 7) Canister connection on lung demand valve assembly
5. Negative Pressure Leak Test (Test 9)	Circuit pressure rises more than 10 mm H_2O (1 mbar) in 60 seconds.	Follow same troubleshooting procedure as in Positive Pressure Leak Test.
6. Preflush Test (Test 10)	Breathing bag does not fully inflate when oxygen cylinder valve is opened.	Repeat test. If bag still does not fully inflate, return oxygen control group to manufacturer or their agent for repair or replacement.

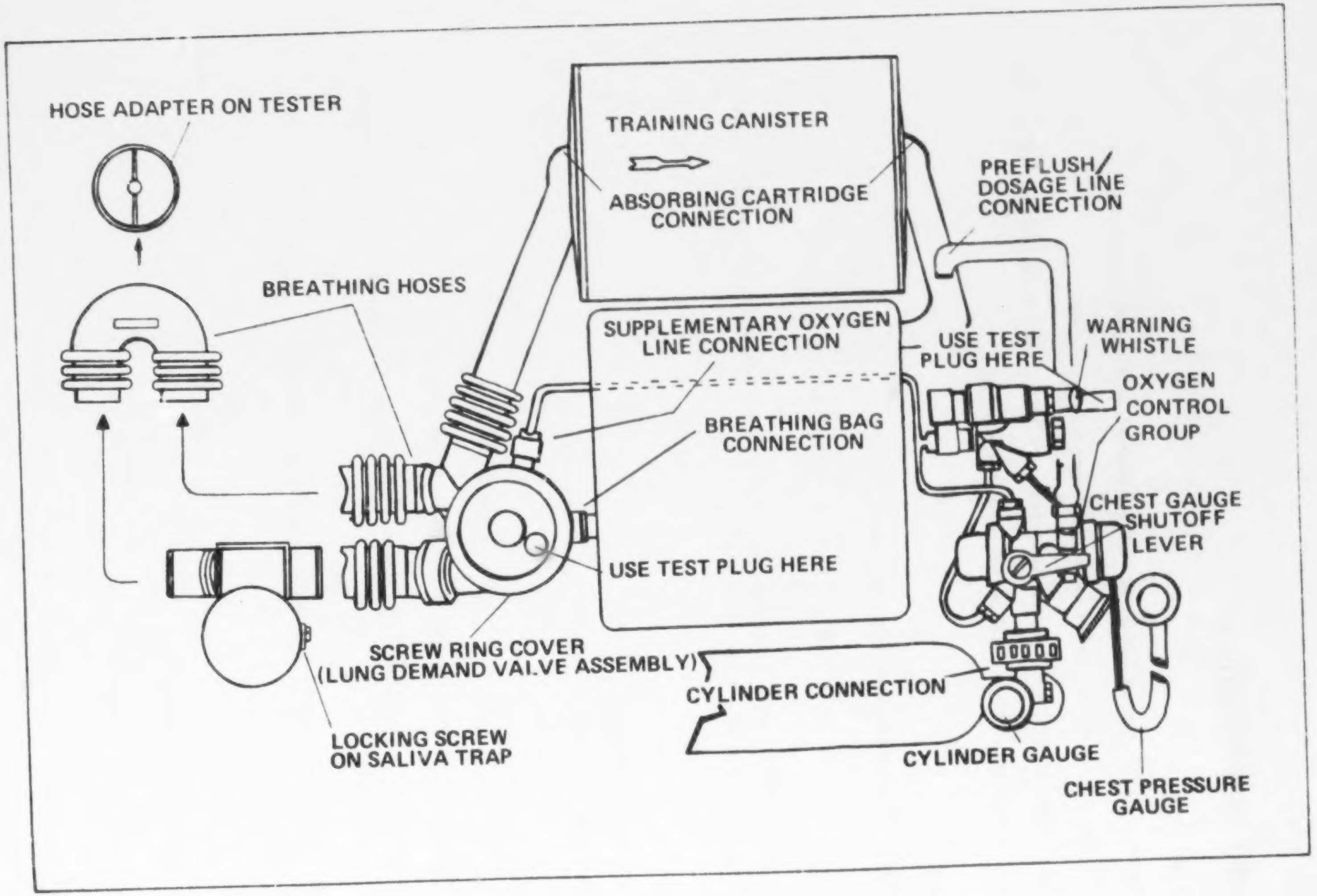
HANDOUT

Visual 17

TEST	PROBLEM	WHAT TO DO
7. Pressure Gauge Equalization Test (Test 10)	Oxygen cylinder gauge and chest pressure gauge readings do not equalize.	Change cylinders and check for equalization, again to determine which gauge is reading incorrectly. If gauges don't equalize within 10 percent of each other, apply soap solution or leak detector to high pressure connections and lines on oxygen control group, warning whistle, and chest gauge line. Tighten leaking connections or replace chest gauge line if cut. If gauges don't equalize, replace defective gauge.
8. Lung Demand Valve Test (Test 11)	Lung demand valve does not open between -10 mm H_2O (-1 mbar) and -40 mm H_2O (-4 mbar).	1. Remove lung demand assembly cover. 2. Inspect diaphragm for punctures. 3. Inspect valve head for seating. 4. Inspect set bolt for freedom of movement. 5. Inspect valve pin lever to insure arm is not bent. 6. If above parts check out properly, replace retaining spring. 7. Replace lung demand valve.
9. Breathing Bag Volume Test (Test 11)	Lung demand valve opens before 10 pump strokes are completed on tester.	1. Make sure bag is full before retesting Pump up bag until pressure relief valve opens. 2. Check to see that bag is inserted properly (Draeger emblem faces outward), the connection at lung demand valve assembly is correct and that bag is not twisted at that connection.
10. Bypass Test (Test 11)	Breathing bag does not inflate in 10 seconds or less when bypass valve activated.	Replace oxygen control group and return malfunctioning unit to manufacturer or their agent.
11. Constant Dosage Test (Test 12)	Dosage does not fall within a range of 1.4 to 1.7 LPM on the red scale of the tester gauge (at sea level).	First, check for proper functioning of the oxygen control group: 1) Remove pre-flush line from cartridge connection socket. 2) Remove breathing hoses and hose adapter from tester. 3) Connect pre-flush line to tester with small diameter hose provided. Be sure apparatus is on and has pre-flushed before attaching hose. 4) Check dosage reading on tester gauge. A reading of 1.4 to 1.7 LPM means oxygen control group is functioning properly. If reading is outside this range, oxygen control group must be replaced.

Visual 17

TEST	PROBLEM	WHAT TO DO
		If oxygen control group checks out, check for low or high dosage reading. Low Dosage (Less than 1.4 LPM) 1. Check all hand tightened connections on apparatus and tester. 2. If low dosage continues, systematically replace "O" rings and washers using same procedure as in Positive Pressure Leak Test. High Dosage (More than 1.7 LPM) 1. Close cylinder valve. After chest gauge reads zero pressure, lift pressure gauge shutoff lever and open cylinder valve. Reconnect preflush line to tester with small hose and read dosage. If dosage is now correct, high pressure is caused by a leak in whistle, which should be fixed. Return defective whistle to manufacturer or their agent. 2. If problem still exists, remove lung demand assembly cover and inspect valve for leaks with soap or leak detecting solution. Replace tin washer with spare provided or replace complete valve, if necessary.
12. Whistle Activation Test (Test 13)	Whistle does not sound at about 700 PSI for 4-hour apparatus or 600 PSI for 3-hour apparatus when oxygen cylinder valve closed.	Return whistle to manufacturer or their agent.
13. Whistle Duration/ Pressure Gauge Shutoff Test (Test 14)	Whistle sounds for less than 20 seconds or more than 60 seconds.	Return whistle to manufacturer or their agent.
	Chest pressure gauge shows reading other than zero.	1. Remove shutoff lever screw. 2. Tighten valve screw counterclockwise. 3. Position valve screw so gauge line is isolated when shutoff lever lifted 30° to 45°. If gauge reads other than zero after retest, replace oxygen control group and return malfunctioning unit to manufacturer or their agent.
14. High- and Medium-Pressure Leak Test (Test 15)	Pressure leak in high- or medium-pressure line or connection.	Retighten connection. If leak continues replace "O" ring or gasket in connection and retighten; or replace complete assembly (i.e., medium-pressure line) if necessary.


HOSE ADAPTER ON TESTER
TRAINING CANISTER
ABSORBING CARTRIDGE CONNECTION
PREFLUSH/ DOSAGE LINE CONNECTION
BREATHING HOSES
SUPPLEMENTARY OXYGEN LINE CONNECTION
USE TEST PLUG HERE
WARNING WHISTLE
OXYGEN CONTROL GROUP
BREATHING BAG CONNECTION
CHEST GAUGE SHUTOFF LEVER
USE TEST PLUG HERE
SCREW RING COVER (LUNG DEMAND VALVE ASSEMBLY)
CYLINDER CONNECTION
LOCKING SCREW ON SALIVA TRAP
CYLINDER GAUGE
CHEST PRESSURE GAUGE

Visual 18

Positive/Negative Pressure Leak Connection

Visual 19

Periodic Maintenance

After each use:

1. Condition ZS/ZST facepiece leather wiper with nonalcohol antifog solution after cleaning.
2. Each time they are removed, replace copper gaskets with new copper gaskets.
3. When cleaning, inspect breathing bag, breathing hoses, and facepiece for stiffness, cracking, and signs of age.
4. When cleaning, inspect lung demand diaphragm for damage and aging.

Every 6 months:

5. Replace "O" ring at oxygen cylinder connection.

Every 2 years:

6. Replace all rubber/Neoprene sealing rings (including those in wiper mechanism of ZS and ZST facepieces).
7. Put in new inhalation valve in lung demand assembly.

Every 3 years:

8. Replace lung demand diaphragm.
9. Discard spare rubber gaskets and sealing rings. Replace with new parts.

Every 5 years:

10. Return oxygen control group to manufacturer or their agent for overhaul.
11. Certified testing facility must retest oxygen cylinder.
12. Minimum service life of breathing bag, breathing hoses, and facepiece. No replacement necessary if the items still function properly.
13. The "O" ring under the speaking diaphragm should be replaced. If speaking diaphragm appears worn, it also can be replaced at this time.

Every 6 years:

14. Replace lung demand assembly.
15. Return warning whistle to manufacturer or their agent for overhaul.

HANDOUT

Demonstration Check 1

PUTTING ON, TAKING OFF THE DRAEGER

Person's Name ________________________________

Instruct each team member to demonstrate for you the proper method of putting on and taking off the Draeger BG 174-A. Watch closely as the person goes through the demonstration. Use the checklist below to record the performance.

Putting on the apparatus

Did the person, in the following order:

1. Coat the inside of the facepiece with anti-fog solution? Yes ____ No ____
2. Adjust the shoulder straps for the proper fit? Yes ____ No ____
3. Hook up the breathing hoses to the tension reliever strap? Yes ____ No ____
4. Attach the breathing hoses to the facepiece correctly? Yes ____ No ____
5. Turn on the apparatus correctly? Yes ____ No ____
6. Put on the facepiece correctly? Yes ____ No ____
7. Check for airtightness of the facepiece? Yes ____ No ____
8. Check the chest pressure gauge? Yes ____ No ____

Taking Off the Apparatus

Did the person, in the following order:

1. Leave the apparatus turned on? Yes ____ No ____
2. Remove the facepiece correctly? Yes ____ No ____
3. Release the tension reliever strap from hoses and loosen wearing harness? Yes ____ No ____
4. Carefully disconnect the breathing hoses from the apparatus, keeping the ends turned up? Yes ____ No ____
5. Take off the apparatus correctly? Yes ____ No ____
6. Close the cylinder valve correctly? Yes ____ No ____
7. Remove the regenerative canister correctly? Yes ____ No ____
8. Disconnect preflush/dosage line? Yes ____ No ____

Demonstration Check 2

CLEANING AND DISINFECTING THE DRAEGER

Person's Name ______________________________

Instruct each team member to demonstrate for you the correct procedure for cleaning the Draeger apparatus. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Removing the Exposed Parts

Did the person:

1. Remove the protective cover correctly? Yes ____ No ____
2. Remove the canister correctly? Yes ____ No ____
   Ask the person what to do in the case of a
   - factory-packed canister?
     (answer: Throw it away)
     refillable canister?
     (answer: Empty it) Yes ____ No ____
3. Remove the O_2 cylinder correctly? Yes ____ No ____
4. Detach breathing hoses from facepiece? Yes ____ No ____
5. Take off saliva trap cap and empty it? Yes ____ No ____
6. Remove the breathing bag carefully? Yes ____ No ____
7. Detach the O_2 line from the demand valve assembly and remove assembly from apparatus? Yes ____ No ____
8. Remove the diaphragm from the diaphragm casing? Yes ____ No ____
9. Clean the casing with a brush or rag? Yes ____ No ____

Cleansing and Disinfecting

(Note: It is not necessary for the person to actually wash, rinse, and dry the parts. Have the student "go through the motions," so to speak, telling you how to properly wash, rinse, and dry the parts.

Did the person:

1. Properly insert the rubber plug into the demand valve?
   (Threaded end screwed onto O_2 line connection on top of assembly; rubber plug inserted into the recess of the valve.) Yes ____ No ____
2. Wash the exposed parts in the properly diluted disinfectant solution?
   (Parts: Facepiece
   Breathing hoses and saliva trap
   Breathing bag
   Lung demand assembly) Yes ____ No ____
3. Parts thoroughly rinsed? Yes ____ No ____
4. Parts thoroughly dried? Yes ____ No ____
5. Wipe down cover and harness? Yes ____ No ____

Reassembling the Apparatus

Did the person:

1. Remove the rubber plug from the demand valve? Yes ____ No ____
2. Properly replace the demand assembly in the apparatus? Yes ____ No ____
3. Properly replace the breathing bag in the apparatus? Yes ____ No ____
4. Attach the saliva trap cap, using a wrench? Yes ____ No

Demonstration Check 3

DRAEGER TESTING PROCEDURE

Person's Name ____

Instruct each team member to demonstrate for you the proper method of testing the Draeger BG 174-A. Watch closely as the person goes through the demonstration. Use the checklist below to record the performance.

Step 1. Visual Inspection
Check for good condition? Yes ____ No ____

Step 2. Insert O_2 Cylinder
Fully charged? Yes ____ No ____

Step 3. Insert Regenerative Canister
Factory-packed: Check seal & expiration? Yes ____ No ____
Refillable: Fill completely? Yes ____ No ____

Step 4. Facepiece and Hoses
Check for good condition? Yes ____ No ____

Step 5. Exhalation Valve
Zero-adjust tester? Yes ____ No ____
Cap off exhalation hose? Yes ____ No ____
Connect inhalation hose to exhalation valve? Yes ____ No ____
Negative pressure pumping? Yes ____ No ____
Observe bag for deflating? Yes ____ No ____

Step 6. Inhalation Valve
Connect inhalation hose to inhalation valve? Yes ____ No ____
Saliva trap vertical? Yes ____ No ____
Positive pressure pumping? Yes ____ No ____
Observe bag for inflating? Yes ____ No ____

Step 7. Relief Valve
Connect exhalation hose to exhalation valve? Yes ____ No ____
Positive pressure pumping? Yes ____ No ____
Relief valve open between +10 and +40 mm H_2O (+1 and +4 mbar)? Yes ____ No ____
Alternate Relief Valve Test (perform after Step 10)

Step 8. Positive Pressure Leak
Plug relief valve and whistle? Yes ____ No ____
Pump up to +100 mm H_2O (+10 mbar)? Yes ____ No ____
Switch tester to Leak Test? Yes ____ No ____
Bleed needle down to +70 mm H_2O (+7 mbar)? Yes ____ No ____
Start stopwatch, observe needle for 60 seconds? Yes ____ No ____
Drop more than 10 mm H_2O (1 mbar)? Yes ____ No ____

Step 9. Negative Pressure Leak
Remove plug from relief valve? Yes ____ No ____
Pump down to -100 mm H_2O (-10 mbar)? Yes ____ No ____
Switch tester to Leak Test? Yes ____ No ____
Bleed needle up to -70 mm H_2O (-7 mbar)? Yes ____ No ____
Start stopwatch, observe needle for 60 seconds? Yes ____ No ____
Rise more than 10 mm H_2O (1 mbar)? Yes ____ No ____

Step 10. Preflush/Pressure Gauge Equalization		
Remove plug from whistle?	Yes ____	No ____
Switch to negative pressure pumping?	Yes ____	No ____
Open O_2 cylinder valve?	Yes ____	No ____
Observe for bag inflation?	Yes ____	No ____
Compare pressure gauges?	Yes ____	No ____
Alternate Relief Valve Test		
Tester set on negative pressure pumping and Leak Test?	Yes ____	No ____
Open cylinder valve?	Yes ____	No ____
Relief valve open between +10 and +40 mm H_2O (+1 and +4 mbar)?	Yes ____	No ____
Step 11. Lung Demand Valve/Breathing Bag Volume		
Negative pressure pumping?	Yes ____	No ____
Count strokes (at least 10 strokes) before demand valve opens?	Yes ____	No ____
Opens between -10 & -40 mm H_2O (-1 & -4 mbar)?	Yes ____	No ____
Step 12. Bypass/Constant Dosage		
Tester set on Red Dosage Test (0.5 to 2 LPM)?	Yes ____	No ____
Plug relief valve vent?	Yes ____	No ____
Press bypass valve until needle reads 1.7 LPM on outside red scale?	Yes ____	No ____
Needle settle between 1.4 and 1.7 LPM?	Yes ____	No ____
Step 13. Whistle Activation		
Remove plug from relief valve vent?	Yes ____	No ____
Close O_2 cylinder valve?	Yes ____	No ____
Whistle sound at 20 to 25% of full cylinder pressure?	Yes ____	No ____
Step 14. Whistle Duration/Pressure Gauge Shutoff		
Set tester on negative pressure pumping?	Yes ____	No ____
Lift pressure gauge shutoff lever?	Yes ____	No ____
Open O_2 cylinder valve?	Yes ____	No ____
Start stopwatch, time the whistle (20 to 60 seconds)?	Yes ____	No ____
Check chest pressure gauge–zero?	Yes ____	No ____
Return shutoff valve to down position?	Yes ____	No ____
Step 15. High- and Medium-Pressure Leaks		
Cylinder valve still open?	Yes ____	No ____
Check for leaks with solution?	Yes ____	No ____
Close cylinder valve after test?	Yes ____	No ____

Suggested Wearing Schedule

The purpose of this wearing schedule is to give new team members a chance to practice wearing an apparatus–breathing, moving, and working with it on. Also they will practice performing team checks.

The three sessions of the wearing schedule are designed to be progressively more demanding. This wearing schedule is provided as a guide. You can tailor it to fit the conditions at your mine site and the needs of your team.

Prior to any practice procedures that involve wearing SCBA, the prospective mine rescue team member should be familiar with the construction, assembly, testing, and care of the apparatus being used, and should have met the physical requirements for mine rescue team membership as outlined in 30 *CFR*, Part 49.

During the initial training sessions, the instructor should monitor the condition of each member closely. Besides checking each team member's general physical condition, the instructor should be on the lookout for signs of potential trouble like these:

1. Rapid, shallow breathing by trainee (indicates inexperience in breathing with an apparatus)

2. Excessively heavy breathing (indicates trainee is excited)

3. Facepiece fit

   a. Too loose–indicated by:

      (1) Shifting of facepiece during activity
      (2) Failure to maintain facepiece seal

   b. Too tight–indicated by:

      (1) Red marks on face when facepiece is removed
      (2) Trainee complains of headache

4. Excessive use of bypass valve by trainee. If apparatus is functioning properly, this indicates:

   (1) Lack of confidence in apparatus
   (2) Poor physical condition of trainee
   or
   (3) Improper breathing technique

5. Rapid consumption of O_2 supply by trainee. If apparatus is functioning properly, this indicates:

   (1) Lack of confidence in apparatus

   (2) Poor physical condition of trainee

   (3) Improper breathing technique

   or

   (4) Excited condition of trainee

TEAM CHECKS FOR DRAEGER

The team should make an initial check when they put on their apparatus and then stop every 15 to 20 minutes thereafter to make checks.

At each rest stop the team member should be asked if he or she is okay and fit to continue the exercise.

A team check should also include the following:

1. Check of pressure gauge

2. Visual check of facepiece seal

3. Check that apparatus harness is properly adjusted and has not moved during the exercise

4. Check that bypass valve operates correctly

During an actual rescue operation the team captain should carry out these checks, and he or she, in turn, should be checked by the co-captain, but during these practice exercises each trainee should be given the opportunity to carry out a check of the other team members. This will ensure that each team member is familiar with the steps and procedures included in a team check.

SESSION 1

It is suggested that the first session be held on the surface. This session should serve primarily to introduce the new trainee to wearing the apparatus. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Walk at normal speed on level ground (for 10 minutes) to allow trainees to become accustomed to the apparatus.

3. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

4. Walk over obstructed course, or rough terrain, or climb small hills (10-15 minutes).

5. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

6. Each carry a 30 to 50 pound weight (a bag of rock dust, sand, fire extinguisher, etc.) for a distance of approximately 100 yards.

7. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

8. Walk on level ground until 45 minutes to one hour of apparatus wearing has been completed.

SESSION 2

It is suggested that this session be held underground if possible. Have the team perform a physically demanding task while under oxygen so they will begin to understand the limitations imposed upon them by self-contained breathing apparatus. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Select a stopping (or bulkhead) or other point that they can walk to and inspect (traveling should take about 15 to 20 minutes).

3. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

4. Perform some physical activity such as loading a mine car with rock dust, sand, timber, etc. or building a stopping (or bulkhead) or other physically demanding activity. Have the team perform team checks every 15 to 20 minutes while doing this.

5. Return to surface.

SESSION 3 (Apparatus training in smoke and/or further activities without smoke)

During this session it would be helpful to expose the team to smoke so that they can experience working in smoke and wearing an apparatus under conditions of limited visibility.

If your mining operation is such that a smoke bomb can be used safely underground, this is the most desirable situation. If this is not possible, any confined area–old building, trailer, or a structure made of brattice cloth or plastic–can be used as a smoke room.

Only Step 4 of this session is designed for use in smoke. An alternate Step 4 is also supplied if smoke cannot be used. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Spend the next 45 minutes to an hour traveling in conditions that approximate the type of conditions they'll encounter in their mine, i.e. climbing ladders, crawling or duck walking in low roof conditions, walking over rough terrain, up and down inclines, etc. Have team stop for team checks every 15 to 20 minutes.

3. Enter smoke area. Before doing this, the team should stop for a team check. Trainees should pay special attention to their facepiece seals to ensure a proper seal–not too loose or too tight.

Procedures that can be stressed and practiced during the team's time in smoke are:

1. Experiencing the disorientation that can occur in heavy smoke.

2. The use of a linkline or lifeline to keep team members together.

3. Following a rail (or a 2 inch x 4 inch for a substitute rail).

4. Feeling and following the rib or side (or wall in a building).

5. Team communications in smoke.

The exercise should be designed so that the team spends no longer than 20 to 30 minutes in smoke. Team should make verbal team checks as necessary and have a complete team check immediately upon leaving the smoke area.

ALTERNATE STEP 4 (If smoke is not used.)

If you are not using smoke, have the team engage in physical activity related to mine rescue, such as carrying a weighted stretcher or stoke's basket, or carrying supplies or objects, such as lumber, timbers, or rolls of brattice. These should be tasks that require more than one person. This activity should take 20-30 minutes. Have team make checks as necessary.

Instructor's Note: This three-session wearing schedule is intended to introduce the trainee to wearing apparatus under a variety of conditions. In annual refresher training the trainees will be performing advanced rescue and recovery procedures while wearing the apparatus.

Appendix

DIFFERENCES BETWEEN DRAEGER MODELS BG 174 and 174-A

1. Retreat warning device. The BG 174 has a reed device rather than a whistle (as in the 174-A) to warn the wearer when his/her oxygen is low. The BG 174's warning device is located in the demand valve assembly, rather than above the oxygen control group, as it is in the "A" models.

2. Pressure gauge. The BG 174 has only one pressure gauge. This is the chest gauge, which is mounted at the end of the pressure gauge line. The "A" models have an additional gauge mounted on the oxygen cylinder.

3. Facepiece/hose divider. The BG 174 does not have a divider in the central hose and facepiece connectors. The BG 174-A does incorporate this feature to help channel inhaled and exhaled air.

4. Other differences:

   The BG 174's bypass valve button has no red ring around it, and no "slip clutch" type cylinder valve. The red ring and slip clutch valve are both featured on the "A" models.

   The BG 174's dosage metering orifice is located on the left side, rather than the right, as on the "A" models.

General Review

Draeger BG 174-A

Directions: Choose the correct answer to each of the following questions.

1. Carbon dioxide is removed from exhaled air by what part of the Draeger BG 174-A?
   a. Preflushing unit.
   b. Pressure reducer.
   c. Breathing bag.
   d. Regenerative canister.
   e. Lung demand valve.

2. Two safety features located within the Draeger BG 174-A's oxygen control group are:
   a. Preflushing unit and pressure gauge shutoff valve.
   b. Manual bypass and pressure gauge shutoff valve.
   c. Pressure gauge shutoff valve and pressure reducer.
   d. Manual bypass and preflushing unit.
   e. Manual bypass and pressure reducer.

3. Limitations of the Draeger BG 174-A include:
   a. It cannot be used in heavy concentrations of carbon monoxide.
   b. It does not function well if stored in cold temperatures (below 14° F, -1° C).
   c. It does not function well in warm temperatures (over 80° F, 27° C).
   d. It requires that some oxygen be present in the outside air in order to function.
   e. All of the above.

4. When drying Draeger BG 174-A parts that have been cleaned, it is suggested that you:
   a. Hang the parts on a line in a dry, well-ventilated clean room, or use a drying unit designed for drying.
   b. Use compressed air.
   c. Hang the parts on a line outside in direct sunlight.
   d. Hang the parts on a line under indirect fluorescent lighting.
   e. The BG 174-A parts should only be cleaned and disinfected by factory-trained personnel.

5. To do the positive pressure leak test on the Draeger BG 174-A, you would perform all of the following steps except:

   a. Remove the rubber plug from the relief valve vent.
   b. Plug the opening in the warning whistle with the cover.
   c. Pump the breathing bag until the meter reads +100 mm H_2O or +10 mbar.
   d. Switch the tester to leak test.
   e. Start the stopwatch and observe the needle for 60 seconds.

6. Testing of the Draeger BG 174-A should be done on the following schedule:

   a. Once every month.
   b. Once every six months.
   c. Every time you wear it.
   d. a and c.
   e. b and c.

7. The following are all steps to be followed when putting on the apparatus except:

   a. Release the springhook from the saliva trap holding device.
   b. Coat the inside of the lens with anti-fog solution.
   c. Turn on the apparatus.
   d. Check the chest pressure gauge.
   e. Check that wiper is lubricated.

8. An oxygen cylinder that will hold approximately 4 hours of oxygen will have a pressure service rating of:

   a. 1.5 liters per minute.
   b. 1800 PSI.
   c. PSI in increments of 200.
   d. 3135 PSI.
   e. 4500 PSI.

9. Oxygen cylinders must be tested hydrostatically and the date of testing stamped on the cylinder every:

   a. Six months.
   b. One year.
   c. Two years.
   d. Three years.
   e. Five years.

10. The unit's automatic preflushing of the breathing bag serves two purposes; they are:

a. Remove carbon dioxide from the bag and provide nitrogen.

b. Remove nitrogen from the bag and provide carbon dioxide.

c. Remove nitrogen from the bag and provide oxygen.

d. Remove oxygen from the bag and provide nitrogen.

e. Remove oxygen from the bag and provide carbon dioxide.

11. The manual bypass valve should be used:

a. To freshen the air in the breathing bag.

b. To cool the air in the breathing bag if it becomes warm.

c. When there is a malfunction in the oxygen control group.

d. All of the above.

e. None of the above.

12. When the warning whistle on the apparatus sounds you have approximately how much time left before you are out of oxygen?

a. 15 minutes.

b. 15 to 30 minutes.

c. 30 to 45 minutes.

d. 45 to 60 minutes.

e. 60 to 90 minutes

13. A maintenance record should include:

a. The total number of hours the apparatus has been used.

b. The installation date for any new part installed in the apparatus.

c. The date on which the apparatus was first placed in service (if known).

d. All of the above.

e. None of the above.

14. The use of a white or red tag placed on the apparatus is recommended because:

a. You know the date of the last inspection of the unit.

b. You can tell immediately that a unit should not be used.

c. It can save valuable time during an actual emergency.

d. All of the above.

e. None of the above.

15. The warning whistle should sound

a. For 5 to 10 seconds.

b. For 10 to 30 seconds.

c. For 20 to 60 seconds.

d. For 30 to 70 seconds.

e. Continually until the oxygen cylinder is completely empty.

16. With the oxygen cylinder valve open, both the oxygen cylinder pressure gauge and the chest pressure gauge should have the same reading within 10 percent of each other. If these readings are not the same:

a. There may be a leak between the oxygen control group and the chest pressure gauge.

b. The exhalation valve is defective.

c. The inhalation valve is defective.

d. There may be a leak in the facepiece.

e. None of the above.

General review answers:

1. d
2. b
3. b
4. a
5. a
6. d
7. a
8. d
9. e
10. c
11. c
12. d
13. d
14. d
15. c
16. a

Glossary

baffle A device to deflect, check, or regulate the flow of air.

compressed oxygen Gaseous oxygen that is contained under pressure.

hydrostatic test A test performed on oxygen cylinders every 5 years to check the cylinder's elasticity. (Water is pumped into the cylinder at a pressure greater than the cylinder's pressure service rating to measure how much the cylinder expands.)

LPM Liters per minute.

lung demand assembly diaphragm A dividing membrane or partition in the Draeger which moves in and out depending on the pressure in the breathing bag.

millibar A unit of atmospheric pressure equal to 1/1000 bar.

millimeters water (mm H_2O) The movement of water (caused by a negative or positive pressure) measured on a scale calibrated in millimeters.

negative pressure Pressure less than normal atmospheric pressure, creating a "sucking in" force.

orifice A hole.

peripheral vision The outer part of the field of vision, especially the sides.

positive pressure Pressure greater than normal atmospheric pressure, creating a "pushing out" force.

preflush Passing oxygen quickly through the Draeger apparatus before actual use to purge any nitrogen and to inflate the breathing bag.

pressure service rating The maximum pressure to which an oxygen cylinder can be filled. (Usually measured in PSI and stamped on the neck of the cylinder.)

PSI Pounds per square inch (pressure).

regenerative canister A part of self-contained breathing apparatus which functions to absorb carbon dioxide from the exhaled breath.

shelf life The length of time that a product can be stored before it begins to deteriorate.

soda lime A chemical which resembles vermiculite, used to absorb or "soak up" carbon dioxide from exhaled air that passes through it.

speaking diaphragm A thin, flexible disc, usually a part of the facepiece, that vibrates (as in a microphone) to allow transmission of the voice to the outside while wearing the facepiece.

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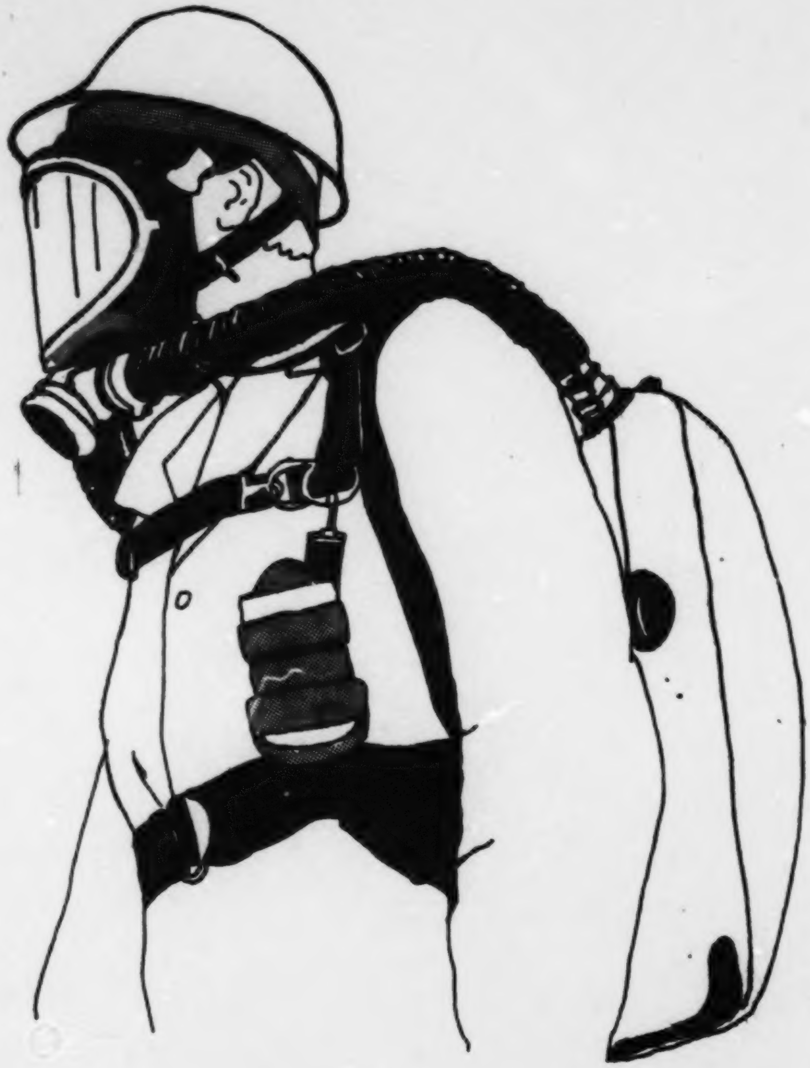
Aerorlox
Self-Contained Breathing Apparatus

Training Module–Initial Mine Rescue

U.S. Department of Labor
Mine Safety and Health Administration
Education and Training Directorate
November 1981

MSHA 2005



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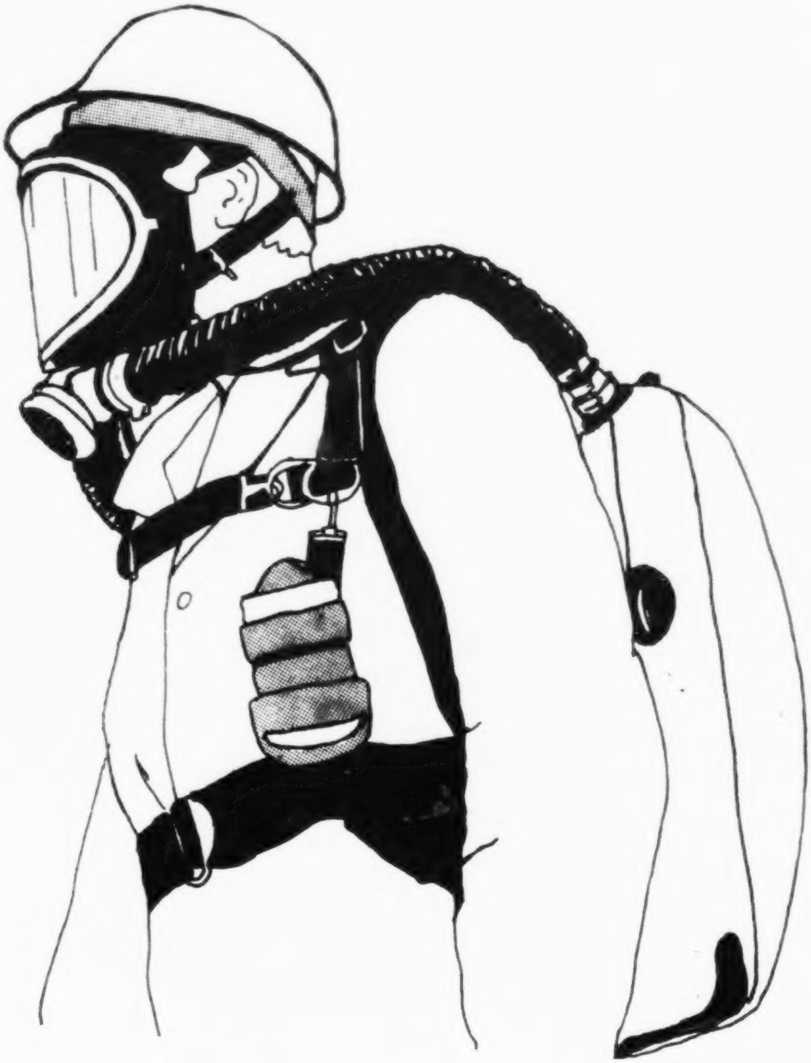

ABOUT THE TRAINING MODULES:

The modules are designed to implement the training of the Nation's mine rescue team members as mandated by Part 49, Subchapter H, Chapter I, Title 30, Code of Federal Regulations pursuant to the Mine Safety and Health Act of 1977. Each of the modules covers a separate subject in a self-contained unit with suggested handouts and visual material to aid in its presentation. They are designed specifically for the training of underground inexperienced or experienced mine rescue team members.

Training module, MSHA 2001, Instructor's Manual for Mine Rescue Training, contains a list of modules in the training program as well as a glossary that can be useful to the instructor.

This program was developed by the Mining Extension Service of West Virginia University for the Mine Safety and Health Administration under United States Bureau of Mines Contract Number JO308002.

Aerorlox
Self-Contained Breathing Apparatus

Training Module–Initial Mine Rescue

U.S. Department of Labor
Raymond J. Donovan, Secretary

Mine Safety and Health Administration
November 1981

MSHA 2005

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Course Objectives

Main objective

The mine rescue team members will be able to properly use and maintain the Aerorlox self-contained oxygen breathing apparatus.

Supportive objectives

The team members will:

1. Describe the Aerorlox 3-hour self-contained breathing apparatus.
2. List the major parts of the Aerorlox and describe their function:
    a. Protective case
    b. Wearing harness
    c. Outer container
    d. Liquid oxygen evaporator
    e. Absorbent canister
    f. Pressure relief valve
    g. Breathing bag
    h. Spear valve
    i. Breathing hoses
    j. Facepiece
    k. Inhalation and exhalation valves
    l. Timer
3. Describe the breathing circuit of the Aerorlox apparatus.
4. Put on and take off the Aerorlox apparatus correctly and check it for proper functioning.
5. Define the apparatus's limitations when it is worn and practice wearing the apparatus.
6. Perform required and recommended testing and maintenance of the Aerorlox apparatus.

Course Materials

Required:

Handouts and visuals from the back of this module

Pencil and paper for each team member

Aerorlox breathing apparatus

Protosorb and liquid oxygen

Equipment necessary for filling apparatus with Protosorb and liquid oxygen (tripod, lox balance, filling funnel and hopper, plough, goggles, and gloves)

Equipment necessary for testing apparatus (Test Set, gaseous oxygen, and a flat-type weighing scale)

Glycerine (a first aid supply)

Disinfectant ("Flordol")

Antifog solution and wiping tissue for facepiece

Suggested:

Overhead projector

Equipment for making copies and/or transparencies

Chalkboard

Optional Resources:

The manufacturer's information which comes packed with the apparatus.

Course Outline

I. The Aerorlox apparatus
  A. Description
  B. How it works

II. Parts of the Aerorlox
  A. Protective case
  B. Wearing harness
  C. Outer container
  D. Liquid oxygen evaporator

E. Absorbent canister
F. Pressure relief valve
G. Breathing bag
H. Spear valve
I. Breathing hoses
J. Vistarama facepiece
K. Inhalation and exhalation valves
L. Timer

III. The breathing circuit (airflow design)
A. Airflow design

IV. Putting on the apparatus
A. Check testing and maintenance records, and Protosorb
B. Fill with liquid oxygen and set timer
C. Make sure relief valve blanking cap is off
D. Visually inspect case, harness, and hoses
E. Attach facepiece and hoses to apparatus
F. Put on unit and adjust
G. Examine and put on facepiece
H. Check airtightness of facepiece seal
I. Check inhalation and exhalation valves

V. Taking off the apparatus
A. Remove facepiece
B. Take off the unit

VI. Wearing the apparatus
A. Limitations
  1. Time limit, work rate, and breathing rate
  2. Liquid oxygen
  3. Temperature range
  4. Size and weight of apparatus
  5. Others
B. Checks to make while wearing the apparatus
C. Wearing schedule

VII. Bench duties

- A. Cleaning and disinfecting the apparatus
  - 1. Disassemble the apparatus
  - 2. Discard Protosorb
  - 3. Attach evaporator test adaptor after liquid oxygen has evaporated
  - 4. Rinse, wash, and disinfect
  - 5. Rinse and dry
- B. Reassembling the apparatus
  - 1. Remove evaporator test adaptor and replace spear valve
  - 2. Reassemble apparatus
- C. Storing the apparatus
- D. Protosorb
  - 1. Description
  - 2. Storage
  - 3. Filling the absorbent canister
    - a. Insert canister in hopper
    - b. Fill with 3.5 pounds Protosorb
    - c. Rotate plough
    - d. Reassemble canister
    - e. Record date
- E. Liquid oxygen
  - 1. Description
  - 2. Storing liquid oxygen
    - a. Storage tanks
    - b. Dewar flasks
    - c. Linde Walker
  - 3. Safety precautions for handling liquid oxygen
  - 4. Filling the evaporator with 6.5 pounds of liquid oxygen
    - a. Tripod and "lox balance"
    - b. Flat type weighing scale
- F. Testing the apparatus
  - 1. Recordkeeping
    - a. Testing records
    - b. Maintenance records
    - c. Tagging
  - 2. The Test Set

3. Testing procedure
    a. Testing prior to each use, or preuse testing
        1. Relief Valve Inward Leak Test
        2. Complete Apparatus Leak Test
    b. Testing every 30 days
        1. Relief Valve Pressure Test
        2. Evaporator Leak Test
        3. Evaporator Flow Check After Wearing
    c. Testing every 3 months
        1. Evaporator Weight Check
    d. Testing every 6 months
        1. Evaporator Full Flow Check

G. Preventive maintenance
1. 60-day preventive maintenance schedule
2. 90-day preventive maintenance schedule
3. Long-term preventive maintenance schedule

Instructor Notes

Note: Throughout this module, the *Visual* notes will recommend that you point out parts, etc., on an actual Aerorlox apparatus. The *Visual* notes will also refer you to various visuals in the back of the module. You should, if possible, make overhead transparencies of the visuals, or sketch them on a chalkboard, or make copies of them to distribute as handouts to the team members (depending on the type of visual).

It is recommended that you use both the apparatus *and* the visuals to aid in an overall understanding of the apparatus. However, the use of one or the other will suffice.

Note to Instructors Training with the 013831.05 Model of the Aerorlox Apparatus:

There are two models of the Aerorlox apparatus: The 013831.05 (1.05) and the 013831.07 (1.07), which is the newer model. The 1.05 is an earlier model and is no longer being manufactured. This lecture is based on the 1.07 model. If the 1.05 differs from the 1.07 description (in the suggested lecture) the difference will be noted in a *Model 1.05 note.* Also, all the differences will be listed in the *Appendix* at the back of this module.

Suggested Lecture

THE AERORLOX APPARATUS

Objective 1: The team members will describe the Aerorlox 3-hour self-contained breathing apparatus.

Visual: Display an Aerorlox apparatus so that the team can get acquainted with it as you begin the lecture, and/or refer to "Visual 1" for a picture of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The Aerorlox is a self-contained, closed-circuit breathing apparatus that uses liquid oxygen as its source of oxygen. Oxygen, as we know it, is gaseous oxygen. That is, oxygen which exists in the air as a gas. But oxygen can also be a liquid.

Oxygen is in a liquid state at −297° F (−183° C). This very cold liquid oxygen will, unless it is stored at −297° F (−183° C), warm up to regular atmospheric temperatures and vaporize to a gas. This is what happens within the Aerorlox apparatus. As the liquid oxygen warms within the unit, it vaporizes or evaporates, emitting the gaseous oxygen which eventually is breathed in by the person wearing the apparatus.

Because the liquid oxygen vaporizes at a cold temperature within the apparatus, the gaseous oxygen produced and the subsequent air you breathe is cool and dry, even when you are working in hot places. Also, because you will be carrying the apparatus on your back as you would a backpack, the coolness from the liquid oxygen will help cool your body.

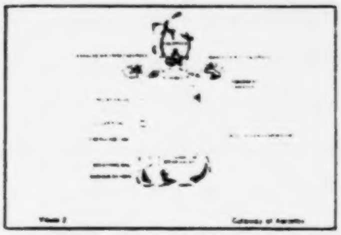
The Aerorlox apparatus, manufactured by the Siebe Gorman Company, has a 3-hour service time and is approved by the Mine Safety and Health Administration (MSHA) and the National Institute of Occupational Safety and Health (NIOSH), as indicated on the unit's approval label.

The Aerorlox weighs about 34 pounds when filled with liquid oxygen, dropping to 28 pounds as it empties. From the moment you fill the unit with liquid oxygen, the oxygen starts to vaporize making the apparatus immediately ready for use.

How It Works

Visual: Use an apparatus as an aid in describing the following air flow through the apparatus, and/or refer to "Visual 2" for a cut-away view of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Note: A more detailed explanation of how the Aerorlox works is given later on in the "Breathing Circuit" section of the module. Do not go into detail at this time. Keep it general.

Basically, the Aerorlox works like this: When you inhale, oxygen-enriched air is drawn out of the breathing bag and into your lungs by way of the inhalation hose.

When you breathe out, the exhaled air passes into the absorbent canister where chemicals remove the carbon dioxide, a by-product of the exhaled air. Then the air is passed along to the breathing bag at the bottom of the unit where it is stored until inhaled again. While this air is being stored, pure oxygen enters from the liquid oxygen evaporator and mixes with the air making the air oxygen-enriched. The oxygen-enriched air then is inhaled and the circular process begins again.

As you see, the Aerorlox is a self-contained, closed-circuit system. You rebreathe the same air, rid of carbon dioxide and enriched with oxygen.

PARTS OF THE AERORLOX

Objective 2: The team members will list the major parts of the Aerorlox and describe their function:

a. Protective case
b. Wearing harness
c. Outer container
d. Liquid oxygen evaporator
e. Absorbent canister
f. Pressure relief valve
g. Breathing bag
h. Spear valve
i. Breathing hoses
j. Facepiece
k. Inhalation and exhalation valves
l. Timer

The Aerorlox apparatus is a relatively simple system. There are no high-pressure components and no valves that you must operate manually.

Visual: Point out the following parts on an apparatus, and/or refer again to "Visual 2" for a cut-away view of the apparatus as you discuss the following section.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

There are four principal parts of the Aerorlox apparatus:

1. The liquid oxygen evaporator;
2. The absorbent canister;
3. The breathing bag; and
4. The facepiece and breathing hoses.

Other parts include: The protective case and wearing harness; the outer container; the pressure relief valve; the spear valve; the inhalation and exhalation valves; and the timer.

Let me explain what these parts are and how they work.

Protective Case

Visual: Point out the protective case on an apparatus and/or refer to "Visual 3" for a picture of the case.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Visual 3
Protective Case and Wearing Harness

The Aerorlox apparatus is housed in a tough molded fiberglass case designed to enclose and protect the breathing unit.

Visual: Point out, on an apparatus, the approval label and the metal ridges (if your apparatus has them) as you discuss them in the following section, and/or point them out on "Visual 3."

Use this visual as an overhead transparency, chalkboard sketch, or handout.

On the front of the case are the approval label (which gives the apparatus's limitations, cautions, and approved time limit) and two metal ridges which aid in sliding the unit if you encounter conditions such as low roof or an obstructed pathway. You can, in these cases, remove the unit from your back (keeping the facepiece on) and push it along in front of you without disturbing the breathing process.

This protective case splits apart into two sections. The sections are hinged at the top so that you can remove the front section alone, and leave the apparatus attached to the back section of the case.

Note: Point out that in this lecture the "front section" of the case refers to the section with the approval label. The "back section" has the wearing harness attached to it.

To remove the apparatus from the fiberglass case, simply:

Demonstration: Demonstrate with an apparatus, how to remove the apparatus from the case. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. Stand the apparatus upright, resting it on the metal frame at the bottom.

2. Release the catch found at the bottom of the front case by pulling on the "D" ring so that it clears the stud.

3. Take the front case completely off by lifting it upward and outward and sliding it off the top hinges.

4. On the outside of the back case, turn the two fasteners to a horizontal position, in line with their slots, so as to unlock the apparatus from the case.

5. Place your hands on the sides of the metal unit, above the breathing bag, and pull and lift the assembly out enough to clear the fasteners from the slots.

6. Now, holding the metal unit firmly with both hands, lift it up so that you can slide out the two hose connections (at the top of the unit) from the slots on the top of the back case. This will clear the unit from the case.

Now, to put the unit back into the protective case:

Demonstration: Demonstrate, with an apparatus, the following steps for replacing the unit in the protective case.

1. **Holding the sides of the outer container, attach the breathing unit to the back case by sliding the two breathing hose connections into the slots at the top of the case.**

2. **Align the fasteners so that they fit through the slots on the back case, and then turn them to the locked, or vertical position.**

3. **Place the front case on the hinge device and close the case.**

4. **Lock the case together by pulling the "D" ring to engage the catch at the bottom of the case.**

Wearing Harness

Visual: Point out the wearing harness on an apparatus, and/or refer again to "Visual 3" for a drawing of the wearing harness.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

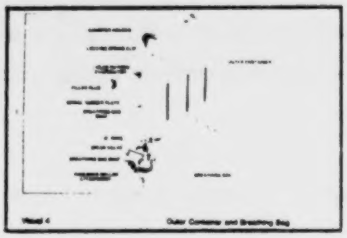
Demonstration: Demonstrate adjusting and fastening the harness belts as you discuss it below. (The team members will learn how to put on the apparatus later on in the lecture.)

The wearing harness, when properly adjusted, allows you to comfortably carry the apparatus on your back. The harness has adjustable padded shoulder straps, a chest strap, and a waist belt. The harness should be adjusted so that the weight of the apparatus rests on your hips.

Outer Container

Visual: Point out, on an apparatus, the outer container, and/or refer to "Visual 4" for a picture of the outer container.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Visual: Point out the filler plug on an apparatus as you discuss it in the following section, and/or refer again to "Visual 4" for a picture of the filler plug.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

When you remove the cover you will see the outer container, and below that, the breathing bag. The outer container is the unit which "contains" the liquid oxygen evaporator and the absorbent canister.

On the left side of the outer container is the filler plug.

The filler plug is used to cap off the opening through which the liquid oxygen is poured when the apparatus is filled with oxygen.

Also located on the left side of the outer container, in the area where the filler plug fits, is the serial number plate.

Visual: Point out the serial number plate on an apparatus, and/or refer to "Visual 5" for a picture of the serial number plate.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The serial number plate states the apparatus's serial number and the breathing bag part number. This plate also gives the body shell weight of the outer container (what the outer container should weigh when it is empty and stripped of all its detachable parts). This weight is important for reasons which we will discuss later.

Liquid Oxygen Evaporator

Visual: Point out, on an apparatus, where the liquid oxygen evaporator is located, and/or refer again to "Visual 4" for a picture of where the evaporator is located.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Inside the central portion of the outer container is the liquid oxygen evaporator. This evaporator is what holds the liquid oxygen when the apparatus is filled. The

evaporator is a perforated metal canister having three walls which serve to help insulate the liquid oxygen from the air temperature so that it does not evaporate too rapidly.

Model 1.05 note: The 1.05's evaporator is filled with absorbent asbestos; the 1.07's evaporator is filled with an absorbing vermiculite material.

The evaporator is filled with an absorbing material which acts like a sponge to sop up and hold the liquid oxygen when the unit is filled. This is so that the liquid will not pass through the walls of the evaporator and leak into the other parts of the apparatus.

Absorbent Canister

Visual: Point out, on an apparatus, where the absorbent canister is located, and/or refer again to "Visual 4" for a picture of the canister holder.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

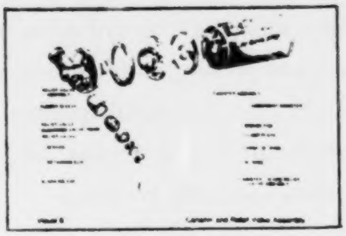
The Aerorlox's absorbent canister fits above the liquid oxygen evaporator in the canister holder at the top of the outer container. Remember, the function of the absorbent canister is to remove carbon dioxide from exhaled air.

The Aerorlox's canister is a refillable-type that holds approximately 3½ pounds of "Protosorb." This is the name of the absorbent chemical approved by MSHA and NIOSH for use with the Aerorlox.

Note: The proper procedure for filling the canister is covered later on in the "Bench Duties" section of the lecture.

Visual: Point out the following parts on an absorbent canister as you discuss the following section, and/or refer to "Visual 6" for a breakdown drawing of the absorbent canister.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The canister lid fits onto the canister holder to hold the canister in place. The lid attaches to the holder by three bayonet pin connections. This lid also has the pressure relief valve attached to it.

To remove the canister from the apparatus:

Demonstration: Demonstrate the following steps for removing the canister from the apparatus. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. Place the outer container on its side with the canister lid facing up. Using the thumb of the left hand, pull out on the locking spring clip (located on the rim of the canister holder) and, with the right hand, press down on the lid while turning it counterclockwise to release the bayonet pins. Then you can remove the canister lid and see the canister itself.

2. Take the canister out of the apparatus.

3. At the top of the canister is a removable piece called the clamp plate. It has a spring on it so that while the canister's lid is in place and pressing on the spring, the clamp plate will keep the Protosorb tightly packed. This forces all the exhaled air passing through the canister to come in contact with the Protosorb.

   To remove this clamp plate from the canister, align the three slots on the plate with the canister's three tabs, and pull the clamp plate off.

4. Now remove the sponge pad from inside the canister.

You will now have a number of parts which comprise the absorbent canister assembly: the canister lid, with a large "O" ring around its rim, the pressure relief valve, a clamp plate, a sponge pad, and the canister itself.

To reassemble the canister and put it back into the apparatus:

Demonstration: Demonstrate the following procedure for replacing the canister in the apparatus. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. First look down into the apparatus's canister holder and check to see that the centralizing cone is in place and in good condition. This rubber centralizing cone functions to centralize the canister while it is in the apparatus.

2. Replace the sponge pad in the canister and put the clamp plate back on by aligning the slots with the tabs and locking the plate into place.

3. Slide the absorbent canister into the holder.

4. Now replace the canister lid. Make sure to position the lid so that the breathing hose connection is at the top of the apparatus, and the relief valve assembly is lowermost. Now, with the thumb of the left hand, retract the locking spring clip, and with the right hand, position the three bayonet pins with their respective slots on the rim of the holder. Press down on the lid and turn clockwise to engage the bayonet assembly, simultaneously releasing the locking spring clip so as to lock the lid in place.

Pressure Relief Valve

Visual: Point out, on an apparatus, where the relief valve is located and what it looks like, and/or refer again to "Visual 6" for a breakdown drawing of the relief valve.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The pressure relief valve allows air to escape from the apparatus if and when the system needs to vent air that you exhale and is not needed to fill the breathing circuit within the apparatus.

The relief valve assembly is fitted to the canister lid. The valve assembly consists of twin mushroom valves which are blue in color. These rubber valves are one-way valves. They allow air to move out of the apparatus, but not back into it.

When completely assembled, the valves fit into a rubber sleeve and have a threaded connection at one end and a screen at the other end. The screen helps to keep dirt and dust from blocking the valves.

To get these valves apart so that they can be maintained and so that you can see how the valves work:

Demonstration: Demonstrate the following procedure for disassembling the relief valve assembly. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. First remove the blanking cap from the front of the valve assembly. Then unscrew the assembly from the canister lid. This blanking cap is equipped with a plastic cord as a reminder to remove the blanking cap before using the apparatus, and also so that you can hang up the blanking cap.

2. Peel back the rubber sleeve so that the top valve pops out. This top valve can be further broken down by removing the round retaining clip from around the inside rim of the valve so that the screen can be taken out.

3. **The second, or bottom valve can then be removed by peeling the rubber sleeve further back to release the valve.**

4. **Now you can see both blue mushroom valve discs–one in each of the blue plastic housing units. When you look closely at both valve discs you will notice that they are very similar except for the two rubber tips which hold the rubber valves in the housings. You can see that the bottommost valve (the valve with the threaded connection) has a long tip. The upper valve has a short tip. The uppermost tip has been cut off to allow the valve to fit on top of the lower valve.**

Now that the valve assembly is disassembled, let's take a look at how it works to release the excess pressure from the apparatus.

Demonstration: Show how excess pressure is released through the relief valve as you describe the following procedure. Either demonstrate it yourself or have a team member do it as you describe the process.

The positive pressure in the system causes the mushroom valves to lift off and move away from the blue plastic surface. The relief valve permits excess air (over 0.8 inches water gauge or 2.0 millibars) coming directly from the exhalation hose to be vented to the outside of the apparatus. This prevents the buildup of pressure within the apparatus. Since these are one-way valves, the air can only move out of the apparatus, not back into the apparatus.

These valves are blue in color. They should not be mixed up with the valves in the facepiece which are black. The relief valve and the facepiece valves are not interchangeable. That is why they are different colors.

To put the relief valve back together again:

Demonstration: Demonstrate the following procedure for reassembling the relief valve. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. First, put the screen in place on the topmost valve and replace the round retaining clip.

2. Now insert the bottommost valve (with the threaded connection) all the way into the rubber sleeve so that the threaded connection sticks entirely out of the bottom of the rubber sleeve.

3. Insert the uppermost valve into the rubber sleeve so that both valves are bumped together and the sleeve comes up over the edge of the top valve.

4. Screw the relief valve onto the canister lid and replace the blanking cap.

Breathing Bag

Visual: Point out, on an apparatus, where the breathing bag is located and what its parts are, and/or refer again to "Visual 4" for a drawing of the breathing bag and its parts.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The breathing bag fits below the evaporator. It is constructed of a flexible rubberized material and has a capacity of over 5 liters (5.25 quarts).

Demonstration: Show the team members how the breathing bag is attached to the apparatus as you discuss the following section.

The bag is attached to the container by two snaps–one on each side of the outer container. If you undo these snaps and pull down on the bag you will see that the bag is also attached to the outer container by a threaded collar. Air entering and leaving the breathing bag travels through this collar. The collar ring has a slot on it which fits around a pin on the outer container connection to ensure correct assembly when connecting the bag to the outer container.

The breathing bag stores oxygen-enriched air until it is inhaled by you. The bag expands and contracts during operation, much like your lungs work. When you exhale air, that air, once filtered by the regenerative canister, goes into the breathing bag where it stays until it is inhaled again.

The breathing bag also collects any moisture from the air as condensation occurs within it.

Spear Valve

Visual: Point out the spear valve on an apparatus, and/or refer to "Visual 4" for a picture of where the spear valve is located, and to "Visual 7" for a close-up drawing of the spear valve.

Use these visuals as overhead transparencies, chalkboard sketches, or handouts.

Visual 7
Spear Valve

The spear valve, located at the bottom of the outer container assembly, is where the oxygen passes through from the evaporator unit to the breathing bag.

Demonstration: Show the team members how the spear valve is attached to the apparatus and how it works, as you discuss the following section.

This removable valve screws into the liquid oxygen evaporator and extends down through the collar ring and into the breathing bag.

The spear valve works like this: The oxygen flows down from the evaporator and into the rubber tab of the spear valve. As the amount of oxygen builds up in this tab and the pressure increases, it forces the slits at the bottom of the tab to open. This allows oxygen to flow out of the valve. These two slits at the bottom of the tab open only for the outward flow of air. The valve does not allow air to flow back into the valve, making this a one-way valve.

Breathing Hoses

Visual: Display the breathing hoses, and/or refer to "Visual 8" for a picture of the hoses.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The breathing hoses used with the Aerorlox apparatus fit onto the top of the apparatus unit. They are made of reinforced corrugated rubber with a silicone finish inside.

Demonstration: As you discuss the following section, demonstrate how the hoses are attached to the facepiece and apparatus.

The hoses are attached to the unit by threaded couplings at the inhalation and exhalation connectors on the apparatus. The inhalation hose is always on the right when wearing the apparatus, and the exhalation hose is on the left, on the side with the canister lid and relief valve assembly. It is impossible to connect these hoses incorrectly because the inhalation hose connection is larger than the exhalation connection; the inhalation hose fits only onto the inhalation connector.

The hoses are fastened onto the facepiece and threaded couplings by the use of screw clamps.

Vistarama Facepiece

Visual: Display the facepiece and point out its parts, and/or refer again to "Visual 8" for a picture of the facepiece.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The Vistarama facepiece used with the Aerorlox apparatus, covers the entire face. It has a five-strap head harness which adjusts to provide a good face-to-facepiece seal, and it has a neck strap that you can put around your neck to support the facepiece while you are wearing the apparatus but don't need to wear the facepiece.

The facepiece has an inflatable inner seal which can be adjusted to individual fit. By removing the red plug from the rubber tube near the bottom of the facepiece, the seal can be blown up to the firmness you need.

Demonstration: Demonstrate the following procedure for inflating the inner seal of the facepiece. Either demonstrate it yourself or have a team member do it as you describe the procedure.

To inflate the seal: Peel back the rubber tube to expose the red plug. Take out the plug and blow up the seal. When it is inflated, pinch off the rubber tube to prevent air from escaping and replace the red plug. Then fold the rubber tube up and around the red plug.

The facepiece also has an inner mask which is a nosecup-type mask that fits over the nose and mouth. The inner mask—which is available in two sizes, normal and small—helps channel air in and out of the facepiece. Two black inhalation valves are located on either side of the inner mask.

Demonstration: Show the team members how the air travels through the facepiece as you discuss the following section.

When the oxygen-enriched air enters the facepiece, it fills the entire facepiece with cool air. This keeps the mask from fogging up since cool, dry air is continuously circulating within the facepiece.

A speaking diaphragm is located on the outside bottom of the facepiece. It screws into place and is easily removed. When you speak with the facepiece on, the speaking diaphragm allows transmission of your voice.

Inhalation and Exhalation Valves

Visual: Point out where the inhalation and exhalation valves are located, and/or refer again to "Visual 8" as you discuss the following section.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The inhalation and exhalation valves are what keep the air flowing in one direction ("in" one way and "out" another way). Without these valves, the exhaled (bad air) would contaminate the good oxygen-enriched air by going back through the inhalation hose and into the breathing bag.

When you exhale, the air goes straight down and out through the exhalation tube at the bottom of the facepiece. It then goes through the exhalation valve which is located in the exhalation hose at the point where the hose joins the chrome hose assembly on the facepiece.

There are three inhalation valves. The main inhalation valve is located near the bottom of the facepiece.

This main valve is a washer-type valve made of very thin rubber. It fits around the outside of the metal tube through which the exhaled air passes as it leaves the facepiece.

Demonstration: As you discuss the inhalation valve, show the team how to get to the inhalation valve so they can see what it looks like and how it fits and works. Refer back to "Visual 8" to identify the following parts that are mentioned.

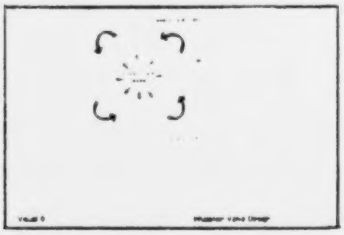
To see this valve you must first pull out the facepiece's inner mask and inner duct. Then use the inhalation valve key (from the Test Set) to unscrew the metal screw-on ring.

Note: Refer to "Visual 18" if you need to know what the inhalation valve key looks like.

Take this metal ring off, along with the plastic ring behind it, and the inhalation valve washer will be exposed.

Visual: Refer to "Visual 9" for a drawing of the inhalation valve design as you discuss the valve in the following section.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



As the air is inhaled, the washer-type inhalation valve moves away from its seat. This allows the air to pass through the valve. The valve opens only for inhaled air, making this a one-way valve.

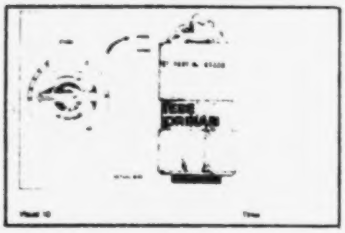
This location, near the heat of the exhaled air, prevents the inhalation valve from freezing up due to the cold oxygen passing through it. We will be discussing how to remove this valve later on during the maintenance part of the lecture.

The two other inhalation valves, as I mentioned before, are located on the facepiece's inner mask. When the air is inhaled, it first comes through the main inhalation valve at the bottom of the facepiece and fills the facepiece. Then it is further inhaled through the inner mask twin inhalation valves and into your lungs.

Timer

Visual: Point out the timer and its parts, and/or refer to "Visual 10" for a picture of the timer.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The timer is a wind-up mechanism which, when set, shows how much time is remaining of the Aerorlox's 3-hour service time. The timer has an automatic warning alarm that goes off when approximately 45 minutes of the pre-set time remain. When carried with the apparatus, the timer hangs from the wearing harness for easy reach.

The timer's dial is divided into hours with metal studs marking each hour. Thus, the timer can be read by sight or by touch if you are in smoke and can't see anything.

The last hour is divided into quarters, with a stud at each 15-minute interval. The knob is the reference point when you are feeling the dial. If you look closely you will see that the knob has a ridge along its spine. This ridge is the "pointer" end of the knob.

Demonstration: Demonstrate how the timer is wound and set, as you discuss the following section.

The timer is wound and set by turning the white knob to the "3 hour" mark. As time expires, the knob unwinds toward the zero position, indicating the time that remains. When approximately 45 minutes remain, a cam on the timer shaft closes electrical contacts and causes an alarm to sound. The alarm will sound for at least 15 minutes.

Demonstration: You may wish to set off the alarm so that the team can hear how it actually sounds.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

(1) What is the purpose of the pressure relief valve?

(Answer: The pressure relief valve prevents the buildup of pressure within the apparatus by venting any excess air in the system (over 0.8 inches water gauge, or 2.0 millibars) to the outside.)

(2) How do you put the apparatus back into the protective case?

(Answer: (1) Holding the sides of the evaporator, slide the breathing hose connections into the hose slots at the top of the back case; (2) Align the fasteners on the back case and turn them to lock in the apparatus (vertical position); (3) Replace front case on hinge device at top and close the case; (4) Engage "D" ring catch at bottom to lock the two cases together.)

(3) What is the purpose of the spear valve?

(Answer: The spear valve allows fresh oxygen to pass into the breathing bag through the two slits at the bottom of the valve's rubber tab. The valve does not allow air to flow back into the evaporator, making the spear valve a one-way valve.)

(4) What is the procedure for replacing the canister lid on the apparatus?

(Answer: (1) Position the canister lid so that the breathing hose connection is at the top of the apparatus, and the relief valve assembly is at the lower portion of the canister holder; (2) With thumb of left hand, retract locking spring clip, and with right hand, position the three bayonet pins with their respective slots on the rim of holder; (3) Press down on lid and turn clockwise to engage bayonet assembly, simultaneously releasing the locking spring clip so as to lock the lid in place.)

(5) What function does the clamp plate perform on the absorbent canister?

(Answer: The clamp plate keeps the Protosorb tightly packed, so that all exhaled air passing through the canister will come in contact with the Protosorb.)

(6) Where are the inhalation and exhalation valves located?

(Answer: The main inhalation valve is located near the bottom of the facepiece. It is a washer-type valve which fits around the outside of the tube through which the exhaled air passes as it leaves the facepiece. Two other inhalation valves are located on the sides of the inner mask of the facepiece.

The exhalation valve is located in the exhalation hose, at the point where the hose joins the chrome hose assembly on the facepiece.)

(7) What is the approved service time for the Aerorlox apparatus?

(Answer: 3 hours.)

(8) What are the two purposes of the timer device?

(Answer: (1) To show the wearer how much time remains under oxygen; and (2) to warn the wearer when approximately 45 minutes under oxygen remain.)

(9) When hooking up the breathing hoses to the apparatus, which hose goes where?

(Answer: The inhalation hose is always on the right side when wearing the apparatus, so the inhalation hose connects onto the right side of the apparatus.

The exhalation hose is always on the left side when wearing the apparatus (on the same side as the relief valve) so the exhalation hose connects to the left side of the apparatus.)

THE BREATHING CIRCUIT

Objective 3: The team members will describe the breathing circuit of the Aerorlox apparatus.

Visual: Use an apparatus as an aid in describing the following airflow through the apparatus, and/or refer again to "Visual 2" for a cut-away view of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Now that we've looked at all the parts of the apparatus, we can follow the flow of air through the breathing circuit and see exactly how the system works.

When you inhale, oxygen-enriched air is drawn out of the breathing bag, through the inhalation hose, into the facepiece, and into your lungs.

When you exhale, the air goes out the exhalation hose and back into the apparatus. If there is excess pressure, the surplus exhaled air is vented through the pressure relief valve. The air which enters the apparatus passes through the absorbent canister where the carbon dioxide is absorbed.

The filtered air then flows out of the canister, passes over one end of the liquid oxygen evaporator and then goes into the breathing bag. This process of going around the cold evaporator cools the air, thus causing moisture in the air to condense and collect in the breathing bag.

As the vaporized oxygen leaves the evaporator, it passes from the innermost core of the evaporator through a series of walls until it reaches the outermost core. Then it travels into the breathing bag. As the cool oxygen flows through the spear valve into the bag and mixes with the filtered air from the absorbent canister, it further cools all the air within the breathing bag. This causes more condensation to occur and collect within the breathing bag.

The oxygen-enriched air from the breathing bag then travels toward the inhalation hose. In the process, it passes over the liquid oxygen evaporator and between baffles to increase its path and further cool the air. The air is then inhaled and the cycle begins again. As you see, the airflow design of the Aerorlox produces cool, dry air from the warm, moist air that is exhaled.

Having the warm air pass over the liquid oxygen evaporator on its way to the breathing bag not only serves to cool the warm air, but also serves to warm up the liquid oxygen so that it will vaporize at an increased rate. This heat exchange process makes the rate of evaporation directly related to your work rate because the harder you work, the more you breathe. And the faster you breathe, the hotter the air in the absorbent canister gets because the Protosorb produces more heat as it processes more air. As this hotter air moves over the evaporator, the oxygen vaporizes faster providing you with more oxygen during hard work.

This heat exchange process also works in reverse–to slow down the rate of vaporization when you are working less and breathing at a slower rate.

The oxygen flow of the Aerorlox is 12 liters per minute (LPM) when full of liquid oxygen. This drops to 4 LPM at the end of the 3-hour time limit.

Model 1.05 note: The 1.05's oxygen flow rate goes from 12 LPM when full, to 5 LPM at the end of 3-hour time limit.

This is more than enough oxygen. A person breathing under normal conditions uses less than 2 liters of oxygen per minute.

Remember, the evaporator continuously produces gaseous oxygen as long as it contains liquid oxygen. The rate of vaporization, however, can increase due to a heavy work rate, and decrease as the work rate slows down.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

(1) What happens to the exhaled air when it passes through the absorbent canister?

(Answer: The carbon dioxide is removed from the exhaled air. In the process the air is heated.)

(2) What is the flow rate of oxygen in the Aerorlox?

(Answer for 1.07 model: 12 liters per minute (LPM) when full with liquid oxygen, dropping down to 4 LPM at end of 3-hour time limit.)
(Answer for 1.05 model: 12 LPM when full with liquid oxygen, dropping down to 5 LPM at end of 3-hour time limit.)

(3) What two things happen in the breathing bag?

(Answer: (1) Air and fresh oxygen mix, producing oxygen-enriched air for the wearer; and (2) moisture from the air condenses and collects in the breathing bag.)

(4) How does the apparatus produce cool, dry air?

(Answer: The exhaled air is cooled as it passes over the liquid oxygen evaporator and again as it mixes with fresh, cool oxygen in the breathing bag. Cooling this air condenses the moisture in it. This moisture collects in the breathing bag, leaving the air cool and dry.)

PUTTING ON THE APPARATUS

Objective 4: The team members will put on and take off the Aerorlox apparatus correctly and check it for proper functioning.

Before putting on your apparatus, make sure that the necessary tests and maintenance have been performed on it and that good Protosorb is in the canister.

Immediately before you put on the apparatus it must be filled with liquid oxygen. Once the oxygen is poured into the evaporator, you must set the timer for 3 hours. Then you are ready to put on the apparatus. Remember. the oxygen begins vaporizing immediately so you don't want to use too much time in getting ready for a rescue, or even for a training session.

Note: Testing and maintaining the apparatus, and filling the canister and evaporator with Protosorb and liquid oxygen, respectively, will be covered in detail later on in the "Bench Duties" section of the module.

Now, to put on the apparatus:

Demonstration: As you discuss this procedure, either put the apparatus on yourself or have a team member put it on. Make sure you cover each step thoroughly.

1. First make sure the relief valve blanking cap is off and the timer is set.

2. Visually inspect the protective case, harness, facepiece and hoses to make sure they are in good condition. Inflate the facepiece's inflatable seal if necessary.

3. Fully assemble the apparatus by attaching the breathing hoses and facepiece to the apparatus unit. Remember, the hose connections are different sizes so the inhalation hose will not fit onto the exhalation connection on the apparatus. These hoses will only fit one way—the correct way.

4. With the apparatus fully assembled, you are ready to put on the unit. First position the facepiece and hoses so that they hang down the front of the apparatus, out of the way.

Note: The front of the apparatus is the side with the approval label on it.

Now slip your arms through the shoulder straps one at a time.

5. Once you have the apparatus on your back, adjust the shoulder straps for a comfortable fit by pulling down on the metal "D" rings at the ends of the straps. Then fasten and adjust the waist belt and chest strap for a snug and comfortable fit. The weight of the unit should rest on your hips.

6. You then bring the facepiece around from behind you and put the neck strap around your neck.

7. The recommended procedure for putting on the facepiece is to fully extend the head harness and grasp the harness and the top of the mask between the thumb and the index finger of each hand. Put your chin into the facepiece and position the mask over your face, making sure that your hair does not interfere with the inflated seal. Stretch the head harness upward and backward over your head. Tighten the straps, starting with the lower straps and then the upper straps. These straps should always be adjusted simultaneously to provide a comfortable fit and a good face-to-facepiece seal.

Once you have the facepiece on, there are three things you should check immediately:

1. The facepiece seal;

2. The inhalation valve; and

3. The exhalation valve.

Demonstration: As you discuss the following procedures, either demonstrate them yourself or have a team member do it.

Check the airtightness of the facepiece seal by momentarily squeezing both breathing hoses with your hands while at the same time trying to inhale and exhale slowly and forcibly. No air should leak past the facepiece seal while inhaling or exhaling.

Note: For the tests to be accurate, hand pressure must be strong enough to effectively close the breathing hoses.

To check the inhalation valve, squeeze the exhalation hose (on the left while wearing) with your hand(s) and attempt to exhale. No air should pass through the inhalation valve, indicating that the one-way valve is working properly (it does not allow you to exhale through the valve).

To check the exhalation valve, squeeze the inhalation hose (right side when wearing) with your hand(s) and attempt to inhale. No air should come through the exhalation valve, indicating that the one-way valve is working properly (it does not allow you to inhale through the valve).

TAKING OFF THE APPARATUS

Demonstration: As you discuss the following procedure, demonstrate how to properly take off the apparatus.

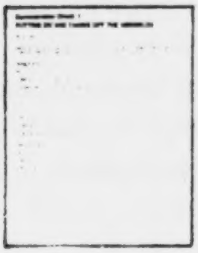
The proper method of removing the apparatus is:

1. First remove the facepiece. Loosen the head harness straps by pushing forward on the plastic tabs of the buckle assembly. Then grip the head harness with both hands at the rear of your head, and stretch it upward and forward over your head.

2. **Once the facepiece is removed, let it hang down in back of you over the front of the apparatus. This will keep it out of the way while you slip out of the apparatus.**

3. **To take off the apparatus, unbuckle the waist and chest straps. Then simply slip out of the shoulder straps.**

Demonstration check: Have the team members put on and remove the apparatus. Use copies of the *Demonstration Check 1–Putting On and Taking Off the Aerorlox* form provided at the back of this module to check each team member's performance. Review the results with each team member.



WEARING THE APPARATUS

Objective 5: The team members will define the apparatus's limitations when it is worn and practice wearing the apparatus.

Limitations

We talked generally, in the Introduction to Self-Contained Breathing Apparatus module, about some of the limitations placed on you when you wear an apparatus. Understanding these limitations and learning to cope with them can have a significant effect on how well you do your job.

Note: At this point, you may wish to review the general limitations from the *Introduction to Self-Contained Breathing Apparatus* module (MSHA 2003).

We'll look now at the specific limitations of the Aerorlox apparatus.

Time Limit, Work Rate, and Breathing Rate

The Aerorlox apparatus is approved by MSHA and NIOSH for 3 hours of use when filled with 6.5 pounds of liquid oxygen. This approval for 3-hour use includes a 25 percent safety factor to cover you in case of periods of hard work and increased breathing when you will be consuming the oxygen supply faster.

Once the liquid oxygen is poured into the evaporator it starts vaporizing immediately, producing gaseous oxygen. There is no way to "turn off" the apparatus in order to save the oxygen supply for a later time. The 3-hour allotment of oxygen begins the minute after the evaporator is filled. The timer should be set immediately after filling the evaporator with liquid oxygen in order to accurately measure the 3-hour time limit. Remember, the timer tells you how much time remains, not exactly how much oxygen is in the evaporator.

Liquid Oxygen

Using liquid oxygen has certain limitations:

1. You cannot store liquid oxygen in the apparatus. The apparatus must be filled with liquid oxygen just before it is used.

2. The storage containers for the liquid oxygen must be routinely topped off.

3. Liquid oxygen supports, and can accelerate, combustion. Therefore spillage of liquid oxygen on any material or area creates a hazardous situation until the liquid is completely evaporated.

4. Liquid oxygen can cause severe frostbite if it comes in contact with your skin. If you get liquid oxygen on your skin, immediately wash the affected area with cold water and apply glycerine to it. A supply of glycerine should be kept on hand for such use.

Note: Precautions for handling liquid oxygen will be covered later on in the "Bench Duties" section of the module.

Temperature Range

Under the "limitations" heading on your Aerorlox unit's approval label, you'll find its rating for cold weather use. The Aerorlox is approved, by MSHA and NIOSH, for use in temperatures down to 32° F (0° C).

Size and Weight of Apparatus

The Aerorlox unit weighs 34 pounds when filled with liquid oxygen. This drops down to 28 pounds as it empties.

Model 1.05 note: The 1.05 model weighs 35 pounds when filled, dropping down to 29 pounds as it empties.

Working and moving with this extra weight is something you will have to get used to during your training sessions.

The apparatus is 19½ inches long, by 15 inches wide, by 6¼ inches deep. The apparatus has a slim profile. However, there may be times when you will have to remove the unit from your back in order to get through a narrow passageway.

If a passageway is not large enough for you and the unit back-to-back, unfasten the straps and slip the unit off your back, being careful not to disturb the facepiece. The breathing unit can then be pushed along in front of you.

Checks to Make While Wearing the Apparatus

After you have put on the apparatus and facepiece and checked the facepiece seal and the inhalation and exhalation valves, you are ready for rescue work or training. Remember, the Aerorlox will function automatically while you work. The only thing you must remember to do is occasionally check the timer to see how much time remains under oxygen.

It is suggested that you also occasionally check to see that the relief valve is functioning properly. To do this, have the team captain or a team member lift the cover of your apparatus and press gently on the breathing bag. Listen for the relief valve to work. If the valve is sticking and not venting properly, this procedure should correct the problem.

Of course, your captain will stop the team periodically and check to see how each team member is doing. During this check, the captain will also check your timer and your wearing harness and facepiece.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

(1) What would you do if you can't fit through a narrow passageway while wearing the apparatus?

(Answer: Take the unit off your back, leaving the facepiece in position. Then push the apparatus along in front of you.)

(2) What does the Aerorlox's timer tell you?

(Answer: How much *time* remains of the original 3 hours. (Not how much oxygen remains.))

(3) Immediately after putting on the apparatus and facepiece, what three things do you need to do and how?

(Answer: You need to check the facepiece seal, and the inhalation and exhalation valves.

(1) To check the facepiece seal: Squeeze both breathing hoses while trying to inhale and exhale slowly, yet forcibly. No air should leak past the facepiece seal, indicating a good seal.

(2) To check the inhalation valve: Squeeze the exhalation hose (on the left while wearing) and attempt to exhale. No air should pass through the inhalation valve.

(3) To check the exhalation valve: Squeeze the inhalation hose (on the right while wearing) and attempt to inhale. No air should come through the exhalation valve.)

(4) What two things do you need to do occasionally while wearing the apparatus?

(Answer: You need to occasionally check the timer to keep track of your time left under oxygen, and you occasionally should check the relief valve to make sure that it is functioning properly. This is done by having the team captain or a team member lift the cover of your apparatus and press gently on the breathing bag while listening for the relief valve to work.)

Wearing Schedule

Note: A *Suggested Wearing Schedule* for the apparatus is included at the back of this module. It presents a three-session practice schedule of exercises and procedures for the wearing of the apparatus. It is recommended that these practice sessions be conducted after you have finished presenting the training contained in this module.

BENCH DUTIES

Objective 6: The team members will perform required and recommended testing and maintenance of the Aerorlox apparatus.

Note: The rest of this module is about apparatus testing and maintenance. Since testing and maintenance programs differ from one mine to another, this section is designed so that you can adapt it to fit your own training needs. Simply use the sections that fulfill your training needs, and leave out those that don't.

When you're under oxygen, every move you make depends on the smooth and proper operation of your breathing apparatus. And your team's performance level is only as good as that of its individual members–including you.

This is why it's important for you to keep your apparatus in top condition. You can keep it operating properly only by testing and maintaining it on a regular basis.

Cleaning and Disinfecting the Apparatus

After each use, the apparatus must be cleaned and disinfected. Also, any parts which show obvious signs of deterioration or damage must be replaced. This includes checking all "O" rings.

The parts of the Aerorlox which have been exposed to the rebreathed air and which therefore need to be cleaned and disinfected are all the parts of the apparatus except the protective case:

1. The facepiece and hoses (do not disassemble these);

2. The outer container;

3. The breathing bag;

4. The spear valve;

5. The absorbent canister assembly (only those components that appear moist need to be cleaned);

6. The canister lid; and

7. The relief valve assembly (do not disassemble this).

The steps for cleaning and disinfecting the Aerorlox apparatus are as follows:

Demonstration: Demonstrate the following procedure for cleaning and disinfecting the apparatus. Either demonstrate it yourself or have a team member do it.

1. Remove the apparatus from the protective case.

2. Disconnect the breathing hoses and breathing bag from the apparatus, and pour out the water that has collected in the breathing bag.

3. Remove the canister lid and take out the absorbent canister using caution because it can be quite hot. Throw out the Protosorb immediately. It cannot be used more than once. Then brush away any loose particles of Protosorb left behind in the canister, especially any that may have become lodged in the canister's inner tube.

Note: The evaporator test adaptor, which is mentioned in the following procedure is part of the Test Set used for testing the Aerorlox. If necessary, refer to "Visual 17" for a picture of what the evaporator test adaptor looks like.

4. Before you go any further, the liquid oxygen in the evaporator must be fully evaporated.

5. Prepare the outer container for cleaning by removing the spear valve from the evaporator and screwing in the evaporator test adaptor. This is a rubber hose with a threaded connection at one end. Seal the end of the hose using a clamp or plug. It is very important that no water get into the evaporator. Therefore make sure that the filler plug is screwed in tightly.

   If water does enter the evaporator, the outer container assembly, stripped of all detachable parts (filler plug, canister, canister lid and relief valve, breathing bag, spear valve, facepiece and hoses), must be weighed. This weight must be compared with the original weight of the unit, which is engraved on the serial number plate on the side of the outer container.

Visual: Point out, on an apparatus, where the engraved weight on the serial number plate is located, and/or refer once again to "Visual 5" for a picture of the serial number plate.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

   If the outer container gains more than 4 ounces (112 grams), it should be taken out of service and returned to the manufacturer.

If it gains less than 4 ounces, it should be heated in an oven to a maximum temperature of 266° F (130° C) for 24 hours. Then, when weighed again, it must be within one ounce (28 grams) of the weight stated on the serial number plate. If it is not within one ounce, take the unit out of service and return it to the manufacturer for repair.

6. Rinse all the parts in clear water. The canister, clamp plate, and sponge pad should only be cleaned if they are moist. Then wash the parts in a cleansing/disinfectant solution containing one part "Flordol" diluted to 40 parts clean water.

Note: "Flordol" is the Aerorlox brand name for their disinfectant solution.

After washing, the equipment should be thoroughly rinsed in clean water to remove all the disinfectant solution.

7. The parts must then be thoroughly dried.

Do not remove the evaporator test adaptor until everything is dry and the spear valve can be replaced.

The facepiece, hoses, and breathing bag should be hung from a line in a dry, well-ventilated room away from direct sunlight and fluorescent lights. Both sunlight and fluorescent light can harm the rubber parts. There is a loop on the bottom of the breathing bag so that the bag can be hung upside down to drain.

The other parts can be laid out on a table so the water can easily drain from inside them. You can, at this point, take apart the relief valve so that it will dry faster.

If it is not practical to let the parts air-dry, you can use a blowdryer set on a cool temperature (not above 140° F, 60° C) to dry the parts more rapidly. You should, however, not use compressed air to dry the parts because it could deposit oil on the parts.

8. When the facepiece and hoses are dry, wipe the inside of the facepiece lens with a soft, lint-free cloth moistened with "Antidim" visor solution.

Note: "Antidim" is Aerorlox's brand name for a visor solution that keeps moisture and dirt from adhering to the facepiece lens.

If smears remain after applying Antidim, they can be polished away with a soft, dry, lint-free cloth.

9. As for cleaning the outside of the apparatus, you should occasionally wipe down the protective case and wearing harness with a damp cloth.

Reassembling the Apparatus

Care should be taken to keep the parts, especially the relief valve and other valves, as free from lint and dirt as possible. The best way to do this is to put the parts back into the apparatus as soon as they are dry and then put the apparatus back into its carrying case. However, do not put the apparatus back together until all the parts are completely dry.

The procedure for reassembling the apparatus is as follows:

Demonstration: Demonstrate the following steps for reassembling the apparatus. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. The first thing to do is remove the test adaptor from the evaporator and replace the spear valve. Make sure that it is in good condition and that its "O" ring is in place before you screw it in.

2. Attach the breathing bag by first screwing on the threaded collar ring. Make sure its "O" ring is in place and that the slot in the ring fits the pin on the outer container connection. Once the collar is screwed on, arrange the telescoping rubber sleeve so that the reinforced rubber ring butts up against the collar ring. When this is done you can pull the bag up around the outer container and snap it into place.

3. Prepare to reassemble the complete canister assembly by checking both "O" rings on the canister lid to make sure that the rubber is still in good condition. Then take a clean, damp cloth and wipe both the "O" rings and the corresponding inside rim of the canister holder to remove any particles of Protosorb. You may wish to apply a lubricant (provided by the manufacturer) to the larger "O" ring to facilitate assembly. This lubricant must not come into contact with the lens of the facepiece.

Note: The following procedures for reassembling the apparatus are covered briefly. More detailed information is available in the preceding "Parts" section of this module, if you wish to refer to it.

4. Reassemble the canister by first putting in the sponge pad and then attaching the clamp plate.

Note: Filling the canister with Protosorb will be covered under the "Protosorb" section of the lecture.

Check the rubber centralizing cone at the far end of the canister holder to make sure it is in place and in good condition.

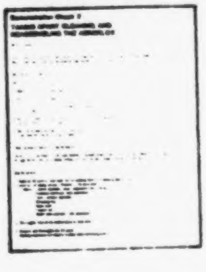
Now you can slide the canister into place.

5. Reassemble the relief valve if it was taken apart. First replace the screen and retaining clip on the top valve. Then insert both valves into the rubber sleeve (bottom valve first). Screw the relief valve onto the canister lid and put the lid back on the canister holder, making sure that the hose connection is near the top of the apparatus and the relief valve is lower.

   When it is in the correct position, retract the locking spring clip with the thumb of your left hand, and with your right hand, press down on the lid and turn it clockwise until the three bayonet pins are engaged. Release the locking spring clip as the pins engage.

6. Put the apparatus back in its protective case. (Slide breathing hose connections into the slots at the top of the back case, align and lock the fasteners, attach the front case, and engage the "D" ring at the bottom to lock the case together.)

Demonstration check: Have each team member remove the parts of the apparatus, and clean and reassemble the apparatus. Use copies of the *Demonstration Check 2–Taking Apart, Cleaning, and Reassembling the Aerorlox* form provided with the module to check each team member's performance. Review the results with each team member.



Storing the Apparatus

To protect the apparatus from moisture, dust, and dirt, you should store the unit, along with the facepiece and hoses, in the storage/carrying case. It should always be stored with the plastic blanking caps over the unit's hose connections and with the blanking cap on the relief valve assembly.

When packing the apparatus into the box, be careful not to distort the rubber parts.

If you are storing the apparatus with Protosorb in it, it is especially important that you keep the blanking caps on everything. These caps will keep moisture out of the Protosorb.

Always store the apparatus in a convenient location so that they will be ready for immediate use.

Note: 30 *CFR*, section 49.6(b) requires that apparatus be stored and maintained in a manner that will ensure readiness for immediate use.

Protosorb

Protosorb is a soda lime mixture which acts, when used in an apparatus, to absorb carbon dioxide from air which is forced through the absorbent canister. It cannot be used more than once in an apparatus. If the Protosorb has been used once, whether for 5 minutes or 3 hours, it must be thrown out.

Protosorb has a shelf life of one year from the date of manufacture. This shelf-life of one year pertains only to the Protosorb while it is stored in its shipping drums.

Once the Protosorb is taken out of the drums and put into the canister, its storage life shortens to 60 days– maximum– provided all the blanking caps are on the apparatus to help keep moisture out. If the blanking caps have not been in place, the Protosorb should not be used.

After 60 days of storage in the apparatus, the Protosorb must be thrown out. You can easily keep track of the 60 days by recording the filling dates on Testing Records, which I will be talking about later on.

Note: Information on testing records is given in the "Recordkeeping" section of the module.

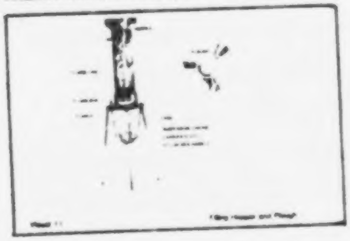
Note: A word of caution about Protosorb: Wet Protosorb is poisonous when ingested, so advise the team to be careful when working with wet Protosorb, especially when they are throwing out the Protosorb after wearing the apparatus.

Filling the Absorbent Canister

Filling the absorbent canister with Protosorb can be done as soon as the apparatus is clean and dry. Or it can be filled at a later time prior to use. Remember, Protosorb can be stored in an apparatus for up to 60 days provided all the blanking caps are on the apparatus.

Visual: At this point, show the team a filling hopper and a plough, and/or refer to "Visual 11" for a picture of a hopper and plough, as you discuss them in the following section.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



To fill the absorbent canister, you need a filling hopper, a plough, and some Protosorb. The hopper is used to fill the canister because it helps to pack the granules close together so they'll work most efficiently during use.

The steps for filling the canister are as follows:

Demonstration: Demonstrate the following steps for filling the canister. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. First set up the hopper by attaching and adjusting the legs so that the hopper is level. You can make this adjustment by screwing the legs in or out to the desired length. A plumb line and bob are situated on the side of the hopper so that you can determine when the hopper is plumb, or level.

2. Next, suspend the carrier plate from the bottom of the hopper and adjust it to allow the absorbent canister to fit vertically by selecting the appropriate links in the suspension chains.

3. Insert the absorbent canister by pulling the carrier plate downward (using the nylon handle below it) and putting in the canister. Position the canister so that it is located in the recess on the underside of the flange when you release the carrier plate.

4. Now slowly pour 3.5 pounds (1.6 kg) of Protosorb into the hopper. The granules should fall freely into the canister. If there is any blockage within the hopper, give it a firm tap on the side.

5. When the canister is filled to ¼ inch (.7 cm) from the top, stop filling the canister and carefully remove it from the hopper.

6. Now place the plough on top of the canister and rotate it until it bottoms on the center tube. This will remove any excess Protosorb in the canister.

7. Remove the plough, insert the sponge pad on top of the Protosorb in the canister, and fit the clamp plate on the canister (align the three slots with tabs and turn to engage and lock).

8. Record the filling date on a Testing Record.

Note: You will be discussing testing records later on in the "Recordkeeping" section of the module.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. How long can Protosorb be stored in an apparatus with the blanking caps on?

   (Answer: No longer than 60 days.)

2. How much Protosorb do you use when filling an apparatus?

   (Answer: 3½ pounds.)

3. Why must you use the hopper to fill the canister?

   (Answer: Using the hopper ensures that the Protosorb is tightly packed.)

4. What do you do next after removing the canister from the hopper?

(Answer: Use the plough to remove any excess Protosorb.)

5. What is the shelf-life of Protosorb?

(Answer: One year.)

Liquid Oxygen

Liquid oxygen is manufactured commercially for medical and industrial purposes. It is made by the fractional distillation of liquid air. This means that nitrogen, carbon dioxide and any impurities are removed from the liquid air, leaving liquid oxygen. The liquid oxygen used in a self-contained breathing apparatus must be 98.5 percent pure.

Liquid oxygen is pale blue in color and extremely cold: −297° F (−183° C). As it rises above this temperature it vaporizes, or evaporates, becoming the gaseous oxygen that we are more familiar with. So unless the liquid oxygen is stored at −297° F (−183° C), it is constantly vaporizing.

The storage containers used at mine rescue stations are designed to keep this vaporization to a minimum by reducing the amount of heat that passes through the container into the liquid oxygen.

Storing Liquid Oxygen

At a mine rescue station, liquid oxygen can be stored "in bulk" in a storage tank. It can be more conveniently stored in Dewar flasks or in a unit known as the Linde Walker.

Storage Tanks

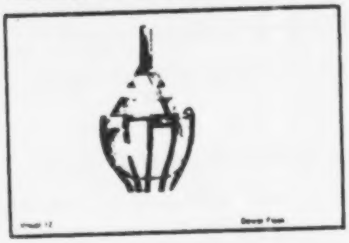
The storage tank is double walled and uses the vacuum principle to minimize heat transfer. Safety valves are incorporated into the tank to prevent a dangerous buildup of internal pressure within the tank.

Even though the storage tank has insulation features, it does not keep the oxygen at -297° F (-183° C). So, the oxygen is constantly, though very slowly, evaporating. And because the volume of liquid oxygen is always decreasing, the tanks need to be refilled or "topped off" about once a month.

Dewar Flasks

Visual: Display a Dewar flask so that the team members can see what it looks like, and/or refer to "Visual 12" for a picture of the Dewar flask.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Liquid oxygen is usually transferred from the storage tank to the Dewar flasks for easy transportation and storage. This storage container, invented by Sir James Dewar, is a vacuum flask made of spun copper. It has an inner vessel and outer vessel whose facing walls are highly polished to prevent heat from radiating into the liquid oxygen.

The flask's bulbous-base, long-neck shape is designed for a purpose: it keeps vaporization to a minimum. Because the top of the neck has only a ½-inch diameter, only a small surface area (½ inch) of liquid oxygen is exposed to the air thereby preventing quick evaporation of the liquid oxygen.

The Dewar flasks have to be "topped off" daily with liquid oxygen in order to keep the level of liquid oxygen within and near the top of the flask's neck.

The Dewar flask holds 60 to 65 pounds of liquid oxygen.

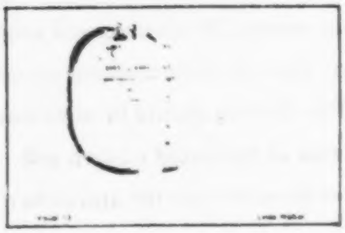
The flasks are fitted with a metal carrying frame with handles attached to it so that you can carry and pour the liquid oxygen directly into the apparatus via a pouring funnel.

No attempt should ever be made to cap off and seal a storage tank or a Dewar flask. This will cause a minor explosion. What happens to cause the explosion is: As the liquid turns to gas, it takes up more space. And if the gas can't escape freely, pressure will build up within the container until the flask or tank explodes to release the pressure.

Linde Walker

Demonstration: Display a Linde Walker so that the team members can see what it looks like and/or refer to "Visual 13" for a picture of the Linde Walker.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The Linde Walker is a storage container that holds about 43 pounds of liquid oxygen and looks like a small steel drum. Unlike filling the apparatus using the Dewar flask (which you need to tilt and pour), the liquid oxygen from the Linde Walker comes out a valve at the top of the unit and flows through a hose to a nozzle known as the phase separator. This nozzle is much like a metal sponge. The liquid oxygen comes out through the pores of the separator and can go directly into the filling funnel and evaporator, filling the apparatus.

Safety Precautions for Handling Liquid Oxygen

Certain precautions should be taken when storing and handling liquid oxygen:

1. Naked lights and smoking should be prohibited within 30 feet of any place where liquid oxygen is stored, handled, or used. Liquid oxygen supports and can accelerate combustion.

2. When transporting liquid oxygen containers in a vehicle, they should be positioned so that they do not move. There should be no smoking in the vehicle.

3. Try to avoid spilling the liquid oxygen, especially where there is oil, grease, asphalt, or other combustible material. If you do spill the liquid oxygen on clothing, you should immediately remove the clothing and keep all ignition sources away from it. Your clothing would be highly flammable. The clothing should be aired out for at least an hour so that all the liquid oxygen will completely vaporize and dissipate into the atmosphere.

4. Because liquid oxygen is so cold, it can cause severe frostbite to the eyes and skin. When transferring the liquid oxygen from the storage tank to the Dewar flask or Linde Walker, or from the flask to the apparatus, you should wear goggles to protect your eyes from the cold gas vapor, and gloves to protect your hands from contact with the liquid oxygen.

   If you do get liquid oxygen on your skin, immediately wash the affected area with cold water and cover it with a good coating of glycerine. Consult a physician for severe frostbite.

5. Be careful when handling the Dewar flask because the flask can become damaged. If you lose the vacuum seal within the flask, the oxygen will quickly become gaseous. If this does occur, the exterior of the flask will quickly become coated with frost.

6. And remember, do not cap and seal off the storage tank or Dewar flasks, as this will cause a minor explosion.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. Why must you be careful when handling liquid oxygen?

   (Answers:

   (1) Spilling liquid oxygen on the body can cause severe frostbite.

   (2) Spilling liquid oxygen on clothing makes the clothing highly flammable.

(3) The Dewar flask can become damaged and lose its vacuum seal. If this happens the liquid oxygen will quickly become gaseous.)

2. What precautions should you take when transferring liquid oxygen from one container to another container?

(Answer: You should wear goggles to protect your eyes from the cold gas vapor, and gloves to protect your hands from contact with the liquid oxygen.)

3. What should be done if liquid oxygen is accidentally spilled on your skin and clothing?

(Answer: Immediately take off the clothing and keep it away from all ignition sources. Then immediately treat your skin by washing the affected area with cold water and covering it with glycerine. If the frostbite is severe, consult a physician.

The clothing should be aired out for at least an hour so that all the liquid oxygen will completely vaporize and dissipate into the atmosphere.)

4. What precautions should be taken in areas where liquid oxygen is stored, handled, or used?

(Answer: There should be no naked lights and no smoking within 30 feet of any place where liquid oxygen is stored, handled, or used.)

Filling the Evaporator With Liquid Oxygen

The time to fill the evaporator with liquid oxygen is immediately before you use the apparatus.

Note: You may wish to tell the team that prior to filling the evaporator with liquid oxygen, they must first check the Test Record to make sure that the Protosorb is still good (within 60 days of filling date) and that the necessary tests have been performed on the apparatus.

Note: There are two methods of weighing the Aerorlox as you fill it with liquid oxygen: (1) tripod and "lox balance"; and (2) flat-type scale. The following lecture will describe both methods–first the tripod method, then the scale method. *Simply omit the section that does not apply to your operation.*

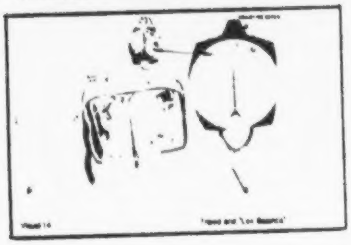
In order to fill the evaporator with liquid oxygen, you need a filling funnel and a flat-type scale or the tripod and "lox balance" which is made especially for filling the Aerorlox with liquid oxygen.

Note: Insulating material should be placed under the apparatus when filling the evaporator from a Dewar flask.

Tripod and Lox Balance

Visual: Display the tripod and lox balance so the team members can see it, and/or refer to "Visual 14" for a drawing of the tripod and lox balance.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The procedure for filling the evaporator using the tripod and lox balance is as follows:

Demonstration: Demonstrate the following procedure for using the tripod and lox balance. *It is not necessary to use liquid oxygen for this demonstration. Simply "go through the motions" of filling the evaporator.* Either demonstrate it yourself or have a team member do it as you describe the procedure.

Remember, you must wear gloves and goggles while handling liquid oxygen.

1. Set up the tripod so that all three legs are fully extended. Then attach the lox balance to the hook at the top of the tripod. Now remove the front of the apparatus's protective case and hang the apparatus from the lox balance by putting the balance's hook through the metal suspension loop on the side of the back case.

2. Remove the filler plug and fully insert the filling funnel into the evaporator.

3. Adjust the lox balance to zero by turning the adjusting screw at the top of the balance.

4. Put on gloves and goggles and pour in the liquid oxygen until the scale reads 6.5 pounds.

5. Remove the filling funnel and immediately replace the filler plug securely. If the filler plug is not replaced right away, ice may form on the threads, making it hard to screw in the plug later on. More importantly though, the filler plug prevents spillage and slows down vaporization of the liquid oxygen.

6. Then immediately set the timer for 3 hours. As you set the timer, check to make sure that the warning device is working. It should sound continuously until you move the knob past the first 45-minute mark.

7. In order to properly distribute the liquid oxygen in the evaporator, stand the unit upright for about 5 seconds. Then turn it on its left side (such that its filler plug is lowermost) for about 5 seconds. Return the unit to the upright position and check to see that the breathing bag is not excessively chilled.

Then put the front of the protective case back onto the apparatus, being careful not to pinch the breathing bag.

Flat-Type Scale

The procedure for filling the evaporator using the flat-type scale is as follows:

Demonstration: Demonstrate the following procedure for using the flat-type scale. *It is not necessary to use liquid oxygen for this demonstration. Simply "go through the motions" for filling the evaporator.* Either demonstrate it yourself or have a team member do it as you describe the procedure.

Remember, you must wear gloves and goggles while handling liquid oxygen.

1. **Set the apparatus on the scale so that the filler plug is up and the unit is level. Either have the protective case open so as to brace the apparatus and keep it level, or remove the protective case and set the outer container on its side. The unit must be completely level in order to completely fill the evaporator.**

2. **Remove the filler plug and fully insert the filling funnel into the evaporator.**

3. **Note the weight of the apparatus on the scale.**

4. Put on gloves and goggles and pour in the liquid oxygen until the scale reads 6.5 pounds more than the previous reading.

5. Remove the filling funnel and immediately replace the filler plug securely. If the filler plug is not replaced right away, ice may form on the threads, making it hard to screw in the plug later on. More importantly though, the filler plug prevents spillage and slows down vaporization of the liquid oxygen.

6. Then immediately set the timer for 3 hours. As you set the timer, check to make sure that the warning device is working. It should sound continuously until you move the knob past the first 45-minute mark.

7. In order to properly distribute the liquid oxygen in the evaporator, stand the unit upright for about 5 seconds. Then turn it on its left side (such that its filler plug is lowermost) for about 5 seconds. Return the unit to the upright position and check to see that the breathing bag is not excessively chilled.

   Then put the apparatus back into the protective case, being careful not to pinch the breathing bag.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. How much liquid oxygen do you pour into the evaporator?

   (Answer: 6.5 pounds.)

2. What steps do you take after you have poured in the liquid oxygen?

(Answer:

(1) Replace the filler plug.
(2) Set the timer for 3 hours.
(3) Distribute the oxygen throughout the evaporator by standing it upright and then on its left side (filler plug side) and then upright again.
(4) Replace the protective case.)

3. What steps do you take to get the lox balance ready for use after you have already placed your apparatus on the lox balance hook?

(Answer: Check to see if the needle indicator is on zero. If it is not, move it to zero by turning the adjusting screw at the top of the scale.)

Note: Depending on how your training program is set up, the team members may or may not be responsible for testing their own apparatus and keeping records. You may leave out information in the next sections that doesn't apply to your program. *However, it's important for all the team members to know what the law says with regard to inspection and recordkeeping.*

Testing the Apparatus

As you have seen thus far, there are a lot of parts and functions on the Aerorlox breathing apparatus. Every one of these parts must at all times be in good to perfect condition, and every function must work precisely as it was designed to work. If there is less than perfect operation anywhere, the apparatus will work either less efficiently or not at all. And if the unit doesn't function properly, neither will you.

To help assure correct functioning, you must test and inspect the apparatus regularly. Testing is an important part of using the apparatus. Just as you wear the apparatus, you must also test it regularly. Federal law requires that the apparatus be tested and inspected at least once every 30 days.

Reference: The reference for testing and inspecting requirements is Title 30, *Code of Federal Regulations* (30 *CFR*), section 49.6(b).

Recordkeeping

Keeping records of tests and repairs made on your apparatus is an important means of ensuring that your unit is always dependable. Accurate, well-kept records can tell you at a glance what condition your unit is in. When kept over long periods of time, records help to identify your unit's "weaknesses" and help you spot minor trouble areas that could turn into major malfunctions. Records also provide you with a basis for developing a replacement schedule for expendable parts.

Testing Records

Visual: Refer to "Visual 15" for a picture of a sample testing record.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Federal law requires that you maintain a record of all tests and inspections performed on the apparatus. This record must be kept at the mine for a period of one year.

Reference: The reference for testing and inspection records is 30 *CFR*, section 49.6(b).

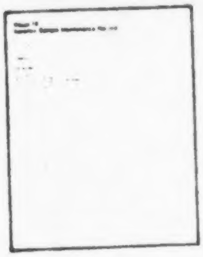
This record, which may be designed as a checklist, should include all the tests and inspections performed on the apparatus. It should also include the test date, the name of the person performing the tests, and the unit number of the apparatus.

The testing record should also note what parts, if any, need to be replaced.

Maintenance Records

Visual: Refer to "Visual 16" for a picture of a sample maintenance record.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



In addition to the testing and inspection record required by law, it is also a good idea to keep a separate maintenance record for each apparatus.

A maintenance record should include:

1. The total number of hours the apparatus has been used;
2. The installation dates for any new parts that have been put on the apparatus; and

3. The date on which the apparatus was first placed in service.

A record like this one helps you establish a regular maintenance program for each apparatus.

Note: At this point, discuss your mine's schedule for and/or experience with replacing expendable parts such as hoses, breathing bags, washers, etc.

Tagging

Visual: Refer to "Visual 17" for a picture of sample tags.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

In addition to keeping testing and maintenance records, it's also a good idea to "tag" each apparatus so that key information can actually be affixed to the apparatus. This tag should be placed on the unit every time it is inspected and it should include information such as:

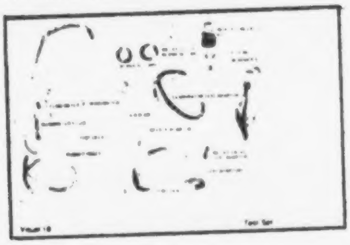
1. The apparatus number;
2. The date of the last inspection;
3. The name or initials of the person who inspected the apparatus;
4. The date Protosorb was added;
5. The dates the tests were performed;
6. Any parts that have been removed for repairs; and
7. Whether or not the apparatus is in good working condition.

It is suggested that a white tag be used if the apparatus has passed all inspection tests and is ready for use. If the unit is not functioning properly or has a part removed for repairs, a red tag should be used. Thus, you will know immediately by the color of the tag whether the apparatus can be used.

The Test Set

Visual: Display the various parts of the Test Set so the team members can see them, and/or refer to "Visual 18" for a picture of all the parts included in the Test Set.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The "Test Set" is designed for and used in testing and maintaining the Aerorlox apparatus. It consists of a number of pieces:

1. Test deck–this includes a manometer (for measuring pressure in inches water gauge) and a flow meter (for measuring air or oxygen flow in liters per minute). Also, you will find a bottle of yellow fluid used to fill the manometer.

2. Evaporator test adaptor–a threaded connection fitted to one end of a 3-foot rubber hose, which fits into the spear valve connection.

3. Two hoses–open at both ends, one clear and one red in color.

4. Relief valve test adaptor–fits the relief valve.

5. Inflatable dummy head–used for sealing the facepiece during testing.

6. Hand-operated air pump and needle connector–used to inflate the dummy head.

7. Bladder kit–used to pressurize the apparatus for testing purposes.

8. "Y" fitting–used to connect hoses to three different connections.

9. Inhalation valve key–used to remove the main inhalation valve.

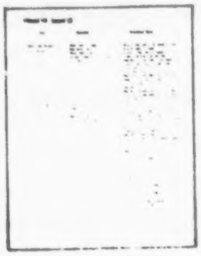
10. Outer container test adaptor–fits the threaded collar connection at the bottom of the outer container.

11. Two threaded caps–fit the breathing hose connections on the apparatus unit.

12. Breathing hose connection test adaptor–fits either of the breathing hose connections on the apparatus unit.

Testing Procedure

__Visual__: Distribute copies of the "Visual 19" handout which is a guide to the following testing procedures. Refer the team members to it as you discuss each of the tests. You may also use an overhead transparency of this visual.



There are seven tests to be performed routinely on the Aerorlox. The manufacturer recommends that these tests be performed at various intervals. For instance, certain tests are to be performed prior to using the apparatus—each and every time. Other tests are to be performed either every 30 days, 3 months, or 6 months.

These tests and their manufacturer-suggested testing schedules are:

1. **Relief Valve Inward Leak Test**—to be performed sometime prior to each use;
2. **Complete Apparatus Leak Test**—to be performed sometime prior to each use;
3. **Relief Valve Pressure Test**—every 30 days;

4. **Evaporator Leak Test–every 30 days;**

5. **Evaporator Flow Check After Wearing–every 30 days;**

6. **Evaporator Weight Check–every 3 months;**

7. **Evaporator Full Flow Check–every 6 months.**

Testing Prior to Each Use (Preuse Testing)

Two tests–the Relief Valve Inward Leak Test and the Complete Apparatus Leak Test–must be done before each wearing of the apparatus. These tests must be done in order, first the relief valve test and then the complete leak test.

Because these tests are done before wearing the apparatus, they are called the Preuse Tests. The Aerorlox can be preuse tested anytime prior to wearing it. The only condition is that it is tested sometime after its last use and prior to its next use, whether for training sessions or actual rescue work.

Before starting these tests, make a visual inspection of the protective case and wearing harness to make sure they are in good condition. This includes examining all straps and metal fittings. Also check to see that you have good Protosorb in the canister. You must have good Protosorb in the canister in order to perform these tests.

Note: Remind the team that Protosorb in the canister stays good for only *60 days* after the filling date written on the "Testing Record" and/or the apparatus's "tag."

If the canister has not been filled since its last use, make sure you fill it now.

Relief Valve Inward Leak Test

For the Relief Valve Inward Leak Test, you will need the following materials:

Note: All the pieces of the Test Set are identified and labeled on "Visual 18" for your reference.

Visual: Display or point out the following materials required for the test, and/or refer to "Visual 18" for pictures of the pieces from the Test Set.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

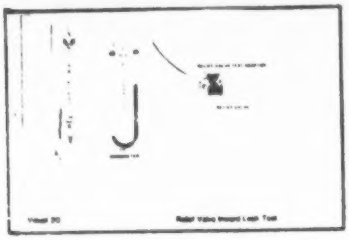
1. **Relief valve test adaptor;**
2. **Manometer filled with fluid to the "O" mark on both sides of "U" tube;**
3. **Two hoses (open at both ends); and**
4. **A clamp or plug to seal one of the hoses.**

The Relief Valve Inward Leak Test checks to see if air leaks inward through the one-way relief valve which is designed to be an outward valve (only allowing air to pass out of the apparatus and not back into it).

The procedure for the Relief Valve Inward Leak Test is as follows:

Visual: Refer to "Visual 20" for a drawing of how the test is set up and performed.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Demonstration: Demonstrate the following Relief Valve Inward Leak Test. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. Remove the relief valve from the canister lid. Make sure the valve discs are clean and moist either by washing the valve assembly in water or by blowing through it.

2. Screw the relief valve test adaptor to the relief valve.

3. Attach one hose from the right side of the manometer to one outlet of the test adaptor, and attach another hose to the other outlet of the test adaptor.

4. Apply a suction of 2 inches water gauge by sucking gently on the open end of the rubber hose until water in the manometer moves to the 2-inch mark on the right side of the "U" tube. Then seal the hose by pinching it or clamping it.

5. **Observe the water column in the "U" tube. It should not fall, indicating no inward leakage in the relief valve.**

If leakage does occur, repeat the procedure starting with blowing through the valve to make sure it is clean and moist.

If the valve still leaks after retesting it, the valve should be replaced.

Note: Remind the team that all test results are to be recorded on the testing record and on the apparatus's tag, if used.

Complete Apparatus Leak Test

Remember that the Relief Valve Inward Leak Test must be done before you start this test.

For the Complete Apparatus Leak Test you will need the following materials:

Visual: Display or point out the following materials required for the test, and/or refer to "Visual 18" for pictures of the pieces from the Test Set.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. **Dummy head inflated to 22½ inches minor circumference;**

2. **Bladder kit;**

3. **Gaseous oxygen;**

4. **"Y" fitting;**

5. **Rubber hose (open at both ends);**

6. **Manometer filled with fluid to the "O" mark on both sides of "U" tube; and**

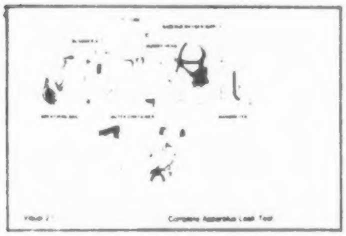
7. **Sink or some other container filled with water.**

Two people are required for this test which tests the airtightness of the apparatus by submerging it, with positive pressure inside, in water.

The procedure for the Complete Apparatus Leak Test is as follows:

Visual: Refer to "Visual 21" for a drawing of how the test is set up and performed.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Demonstration: Demonstrate the following Complete Leak Test. Two people are required to do this test, so have a team member help you or have two members of the team demonstrate the procedure as you describe it.

1. First of all, there should be no liquid oxygen in the evaporator before you begin this test.

2. Take the apparatus out of its protective case and fully assemble it, including attaching the breathing hoses and facepiece so that they are free of kinks in relation to the "as worn" position. The breathing bag should not be snapped to the sides of the outer container. It should be attached to the unit by only the threaded collar connection.

3. Check all screw-tight connections to make sure they are finger-tight.

4. Make sure the relief valve blanking cap is on the relief valve so that no water will enter through the relief valve.

5. Inflate, if not done already, the dummy head to approximately 22½ inches minor circumference.

6. Remove the evaporator filler plug and attach the bladder kit by screwing its threaded connection into the hole for the filler plug.

7. Then put the inflated dummy head into the facepiece and tighten the straps until a good seal is formed. (It may be necessary to inflate the inflatable seal around the facepiece.)

8. Now use gaseous oxygen to pressurize the apparatus and bladder kit to about 6 inches water gauge. Use the "Y" fitting and hoses to connect the bladder kit, manometer, and oxygen supply. Inflate the bladder with gaseous oxygen until the fluid in the manometer reaches 6 inches water gauge (registers 6 on left side of the "U" tube). (Make sure the tap on the bladder kit is in the open position, in line with the pipe.)

9. When inflation reaches 6 inches water gauge, close the tap on the bladder kit and remove all the extra equipment used to inflate the bladder kit.

   If gaseous oxygen is not available for this step, the apparatus can be pressurized by mouth inflation through the bladder kit. This method, however, is not recommended except in emergencies because moisture from the exhaled air will enter the evaporator.

Note: During training, periodic checks of the inflation pressure should be made to familiarize the team members with how the bladder should look when properly inflated.

10. Now, with two people working together, immerse the entire apparatus with the bladder kit in water. (Make sure relief valve blanking cap is on.) One person should hold the entire apparatus under water while the second person pushes the breathing bag to the bottom of the tank or sink so that the bag touches bottom. The second person should gently squeeze the bag to check for leaks. Make sure the bladder kit remains inflated. A deflating bladder indicates a leak.

READEX FICHE

11. Check for leaks at the various connections by watching for air bubbles. There must be no leaks at the connections. If you see air bubbles, take the apparatus out of the water and try tightening the connections. Also check the "O" rings and replace if necessary. Then retest the apparatus.

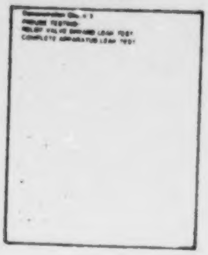
12. When you have completed the test, take the apparatus out of the water and wipe it dry, particularly around the filler plug area. Remove the bladder kit carefully so that no water enters the evaporator. Replace the filler plug immediately to ensure that no water gets into the evaporator.

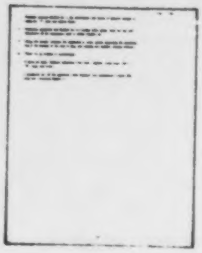
13. Fasten the breathing bag snaps to the outer container and remove the dummy head.

If you are going to wear the apparatus directly after this test, all you need to do is fill the evaporator with liquid oxygen, remove the relief valve blanking cap, and you are ready to go. Otherwise the apparatus can be stored for its next use.

Note: Remind the team that all test results must be recorded on the testing record, and on the apparatus's tag, if used.

Demonstration check: **Have each team member perform the two Preuse Tests. Use copies of the *Demonstration Check 3–Preuse Testing* form provided with the module to check each team member's performance. Review the results with each team member.**





Testing Every 30 Days

The tests that are to be done every 30 days are the:

1. **Relief Valve Pressure Test;**
2. **Evaporator Leak Test; and**
3. **Evaporator Flow Check After Wearing.**

These tests must be done every 30 days regardless of whether the apparatus is worn or not. The purpose of these tests is to make sure the relief valve and evaporator are functioning as they should.

Relief Valve Pressure Test

For the Relief Valve Pressure Test you will need the following materials:

Visual: Display or point out the following materials required for this test and/or refer to "Visual 18" for pictures of the pieces from the Test Set.

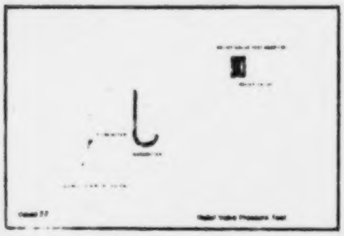
Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. Relief valve test adaptor;
2. Manometer filled with fluid to "O" mark on both sides of "U" tube;
3. Three rubber hoses;
4. Flow meter; and
5. Auxiliary supply of air or oxygen.

The procedure for the Relief Valve Pressure Test is as follows:

Visual: Refer to "Visual 22" for a drawing of how the test is set up and performed.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Demonstration: Demonstrate the following Relief Valve Pressure Test. Either demonstate it yourself or have a team member do it as you describe the procedure.

1. Remove the relief valve from the canister lid. Make sure the valve discs are clean and moist either by washing the valve assembly in water or by blowing through it.

2. Screw the relief valve test adaptor to the relief valve.

3. Attach a hose from the right side of the manometer to one outlet of the test adaptor. Attach another hose from the other outlet of the test adaptor to the top of the flow meter.

4. Attach a third rubber hose to the bottom of the flow meter. By means of this hose, pass a one liter-per-minute flow of oxygen or auxiliary air through the moist valve. You should be able to hear the relief valve releasing the air or oxygen.

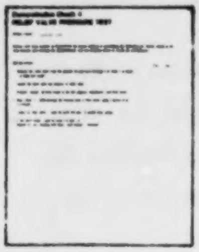
5. When the relief valve opens to release the air or oxygen, the fluid in the manometer tube's left side should read between 0.8 and 1.6 inches water gauge.

6. If the relief valve does not release air between 0.8 and 1.6 inches water gauge, repeat the procedure starting with washing the valve assembly in water or blowing through it to ensure that the valve discs are clean and moist.

7. If the valve continues to fail, discard and replace the entire assembly.

Note: There are separate *Demonstration Checks* for each of the following tests. They will be noted following each testing procedure; however you may wish to postpone each test until the end of the testing section, when all the *Demonstration Checks* can be done together.

Demonstration check: Have each team member perform the Relief Valve Pressure Test. Use copies of the *Demonstration Check 4–Relief Valve Pressure Test* form provided with the module to check each team member's performance. Review the results with each team member.



Evaporator Leak Test

For the Evaporator Leak Test you will need the following materials:

Visual: Display or point out the following materials required for this test, and/or refer to "Visual 18" for pictures of the pieces from the Test Set.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. Evaporator test adaptor with rubber hose;

2. "Y" fitting;

3. Manometer filled with fluid to the "O" mark on both sides of the "U" tube;

4. Two hoses and a clamp; and

5. Gaseous oxygen.

The procedure for the Evaporator Leak Test is as follows:

Visual: Refer to "Visual 23" for a drawing of how the test is set up and performed.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Demonstration: Demonstrate the following Evaporator Leak Test. Either demonstrate it yourself or have a team member do it while you describe the procedure.

1. First of all, there should be no liquid oxygen in the evaporator before you begin this test.

2. Remove the outer container assembly from the protective case, and disconnect the breathing bag.

3. Remove the spear valve and screw in the evaporator test adaptor with its rubber hose.

4. Connect the open end of the evaporator test adaptor hose to one of the top outlets of the "Y" fitting. The other outlet of the "Y" fitting should be connected by a hose to the right side of the manometer. The bottom outlet of the "Y" fitting should be connected by a hose to a source of gaseous oxygen.

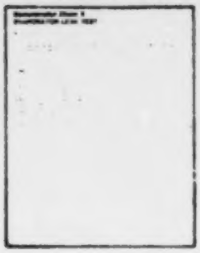
5. Pressurize the evaporator with gaseous oxygen until the fluid in the manometer's left side reads 6 inches water gauge.

6. Pinch or clamp the end of the oxygen hose so that it is completely sealed.

7. The pressure reading on the manometer should not fall, indicating that there are no leaks in the evaporator.

8. If you detect a leak, first check the test equipment and all hose connections. Then repeat the test. If the evaporator continues to leak, take the assembly out of service and return it to the manufacturer for repair.

Demonstration check: Have each team member perform the Evaporator Leak Test. Use copies of the *Demonstration Check 5–Evaporator Leak Test* form provided with the module to check each team member's performance. Review the results with each team member.



Evaporator Flow Check After Wearing

The Evaporator Flow Check After Wearing should be done after the apparatus has been worn for 3 hours. This test is performed with the liquid oxygen which remains in the evaporator after 3 hours of use.

For this test you will need the following materials from the Test Set:

Visual: Display or point out the following pieces from the Test Set, and/or refer to "Visual 18" for pictures of the pieces.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

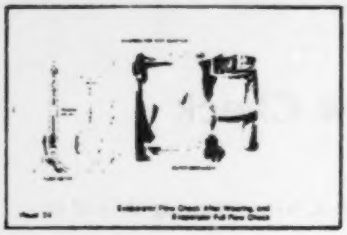
1. **Evaporator test adaptor with rubber hose; and**

2. **Flow meter.**

The procedure for the Evaporator Flow Check After Wearing is as follows:

Visual: Refer to "Visual 24" for a drawing of how the test is set up and performed.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Demonstration: Demonstrate the following Evaporator Flow Check. Either demonstrate it yourself or have a team member do it while you describe the procedure.

1. **After wearing the apparatus for 3 hours, remove the outer container from the protective case.**

2. **Remove the breathing bag and evaporator spear valve and screw in the evaporator test adaptor with rubber hose. Stand the outer container on its right side so that the filler plug is uppermost.**

3. **Connect the open end of the evaporator test adaptor hose to the bottom of the flow meter. The reading on the flow meter will be the rate of vaporization of oxygen.**

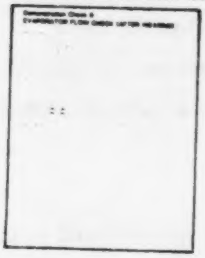
4. To satisfy this test the flow of oxygen should not be less than:

   Model 1.05–5 LPM, 3 hours after filling.

   Model 1.07–3 LPM, 3 hours after filling.

5. If the oxygen flow rate is not correct, proceed to the "Evaporator Weight Check" to see if the evaporator has water in it. If the evaporator has gained weight, use the recommended procedure for drying out the evaporator. If the evaporator is not overweight, the outer container assembly should be withdrawn from service and returned to the manufacturer for repair.

Demonstration check: Have each team member perform the Evaporator Flow Check After Wearing. Use copies of the *Demonstration Check 6–Evaporator Flow Check After Wearing* form provided with the module to check each team member's performance. Review the results with each team member.



Testing Every 3 Months

Only one test is scheduled to be done every 3 months–the Evaporator Weight Check.

Evaporator Weight Check

For this test you will need a flat-type weighing scale.

The procedure for the Evaporator Weight Check is as follows:

Demonstration: Demonstrate the following Evaporator Weight Check. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. **First of all it is important that no liquid oxygen be in the evaporator. It must be completely empty.**
2. **Remove all the detachable parts from the outer container assembly (filler plug, canister, canister lid and relief valve, breathing bag, spear valve, facepiece and hoses).**
3. **Put the outer container on a flat-type scale and note the weight. This weight must be compared with the original weight of the outer container which is engraved on the serial number plate on the side of the outer container.**

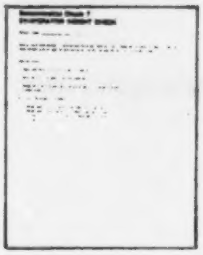
Visual: Point out, on an apparatus, where the engraved weight on the serial number plate is located, and/or refer to "Visual 5" for a drawing of the serial number plate.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

4. If the outer container gains more than 4 ounces (112 grams), it should be tagged as defective and returned to the manufacturer.

If it gains between 1 and 4 ounces, it should be heated in an oven to a maximum temperature of 266° F (130° C) for 24 hours. Then, when weighed again it must be within one ounce (28 grams) of that stated on the serial number plate. If it is not within one ounce, tag the unit as defective and return it to the manufacturer for repair.

Demonstration check: Have each team member perform the Evaporator Weight Check. Use copies of the *Demonstration Check 7–Evaporator Weight Check* form provided with the module to check each team member's performance. Review the results with each team member.



Testing Every 6 Months

Only one test is scheduled to be done every 6 months–the Evaporator Full Flow Check.

Evaporator Full Flow Check

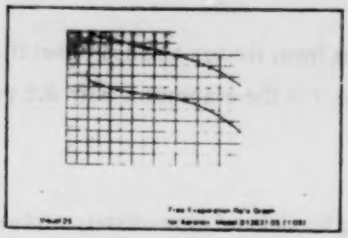
For this test you will need the following materials:

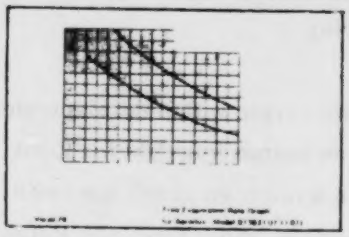
Visual: Display or point out the following materials required for the test, and/or refer to "Visual 18" for pictures of the pieces from the Test Set.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. **Liquid oxygen;**
2. **Filling funnel;**
3. **Evaporator test adaptor with rubber hose;**
4. **Flow meter;**
5. **Tripod and lox balance or flat-type weighing scale; and**
6. **"Free Evaporation Rate Graph."**

Visual: Distribute copies of the *Free Evaporation Rate Graph* ("Visual 25" for Model 1.05, and "Visual 26" for Model 1.07), so that the team members can refer to them when you discuss the flow rate.





The procedure for the Evaporator Full Flow Check is as follows:

Visual: Refer to "Visual 24" for a drawing of how the test is set up and performed.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Demonstration: Demonstrate the following Evaporator Full Flow Check. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. **Remove the outer container from the protective case and disconnect the breathing bag.**

2. **Hang the apparatus from the lox balance or set it up on a flat-type scale. Fill the evaporator with 6.5 pounds of liquid oxygen.**

3. **Remove the filling funnel and immediately replace and tighten the filler plug.**

4. **Distribute the liquid oxygen within the evaporator by holding the outer container upright for about 5 seconds and then laying it on its left side (with filler plug lowermost) for about 5 seconds. Return the outer container to its upright position and then lay it on its right side again so that the filler plug is uppermost.**

5. **Remove the spear valve from the evaporator and screw in the evaporator test adaptor with rubber hose. Connect the open end of the evaporator test adaptor hose to the bottom of the flow meter.**

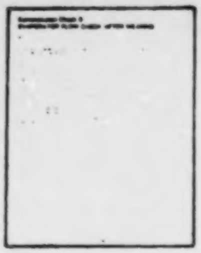
6. Compare the flow rate registering on the flow meter with the acceptable rate given on the Free Evaporation Rate Graph. The flow rate should not be less than the minimum rate indicated on the graph.

Visual: Refer the team members to their handouts of the *Free Evaporation Rate Graph*, either "Visual 25" (Model 1.05) or "Visual 26" (Model 1.07). You may also use an overhead transparency or chalkboard sketch of this visual.

7. If the flow rate is wrong, perform an evaporator weight check to see if the evaporator has water in it. If possible, correct the problem and perform the Evaporator Full Flow Check again. If the problem cannot be corrected, withdraw the outer container from service, tag it as defective, and return it to the manufacturer for repair.

This concludes testing the apparatus. Do not forget to record all the test results on the Testing Record and on the apparatus's tag for easy reference. If the unit is defective or has a part removed, make sure to also note this on the Record and on the apparatus's tag.

Demonstration check: Have each team member perform the Evaporator Full Flow Check. Use copies of the *Demonstration Check 8–Evaporator Full Flow Check* form provided with the module to check each team member's performance. Review the results with each team member.



Note: Do all the *Demonstration Checks* now if you postponed doing them during the testing lecture.

Preventive Maintenance

Visual: Distribute copies of the "Visual 27" handout which is a guide to the following maintenance schedule. Refer team members to it as you discuss each maintenance schedule. You may also use an overhead transparency or chalkboard sketch of this visual.

During regular use of the apparatus, you will be replacing any defective parts that are found during routine testing and inspections. In addition to this routine replacement of parts, the manufacturer recommends that you follow a preventive maintenance schedule for the apparatus. This schedule is divided according to what parts need to be replaced after they've been in service for certain lengths of time. There are the following schedules for parts replacement:

1. **60-day preventive maintenance;**
2. **90-day preventive maintenance; and**
3. **Long-term preventive maintenance.**

60-Day Preventive Maintenance Schedule

The apparatus should be examined in detail at least once every 60 days and the results should be recorded on the Maintenance Record. In particular, the rubber components should be examined by carefully flexing surfaces and creases to check for signs of damage or deterioration. If the parts are in bad condition they should be replaced immediately.

When looking over the facepiece and hoses, you should also examine the inhalation and exhalation valves.

Visual: As you discuss the following section, you may wish to refer back to "Visual 8" for a detailed drawing of how the inhalation valve is fitted into the facepiece.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

To get the inhalation valve out of the facepiece, remove the inner mask and inner duct by pulling them out. Then use the special inhalation valve key from the Test Set to remove the metal ring.

Note: The inhalation valve key is identified and labeled on "Visual 18."

The next piece is a plastic ring that can be removed by lightly flexing the chin section of the facepiece so as to dislodge or pop out the ring. This leaves the thin inhalation valve washer exposed.

The inhalation valve washer can then be taken out and examined. If the valve is in good condition, reassemble the entire assembly. If the valve washer is in bad condition, throw it away and put a new inhalation valve washer into the assembly.

Note: Remind the team to put a *DO NOT USE* tag on the apparatus if the defective part cannot be replaced immediately.

When reassembling the inhalation valve assembly, make sure that the valve washer is properly fitted so it is not pinched by the plastic ring which fits next to the washer. Also ensure that the slot in the plastic ring is properly located before the metal screw-on ring is fitted and firmly tightened by the inhalation valve key.

To get the exhalation valve out of the exhalation hose, remove the screw clamp near the chrome hose attachment and take off the exhalation hose. Then take out the exhalation valve and examine it without disassembling it. Carefully examine the condition of the mushroom valve component.

If it's okay, reassemble the hose assembly. If it's in bad condition, throw it away and replace the assembly with a new exhalation valve.

Note: Remind the team to put a *DO NOT USE* tag on the apparatus if the defective part cannot be replaced immediately.

The relief valve should also be examined.

Visual: You may wish to refer back to "Visual 6" for a detailed drawing of how the relief valve is disassembled.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

To disassemble the relief valve, unscrew it from the canister lid and peel back the rubber sleeve so that both valves come out. Take off the round retaining clip and screen from the top valve and carefully examine the condition of both mushroom valves. If they are okay, reassemble the valve assembly. If one or both of them are in bad condition, throw them away and replace them with new mushroom valves.

Note: New mushroom valves will have long tips on them. It will be necessary, if you use a new mushroom component in the *top valve*, to cut off the tip once it is in place.

Also, remind the team to put a *DO NOT USE* tag on the apparatus if the defective part cannot be replaced immediately.

90–Day Preventive Maintenance Schedule

The timer battery should be changed every 90 days or after 30 operational sessions, whichever is sooner. The battery is a PP3 which will give 10 hours of continuous signal.

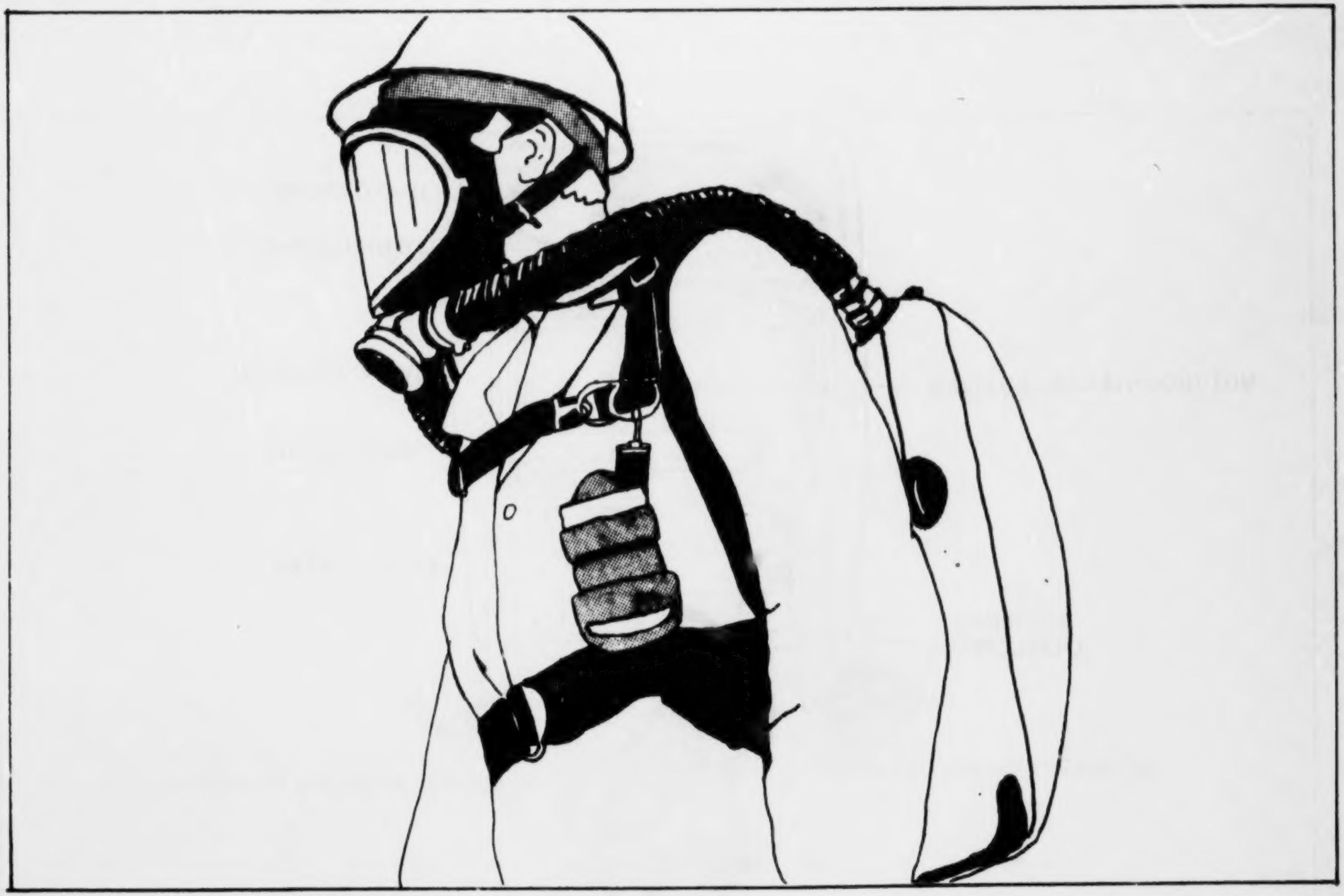
To change the battery, unscrew the base of the timer and remove the battery and alarm. The connections to the battery are the click-on type. When these are removed, the battery will slide out of its case and the new battery can be inserted.

The timer dial must be on zero during this procedure. Otherwise damage to the transistorized alarm may result if the polarity of the battery is accidentally reversed.

Long–Term Preventive Maintenance Schedule

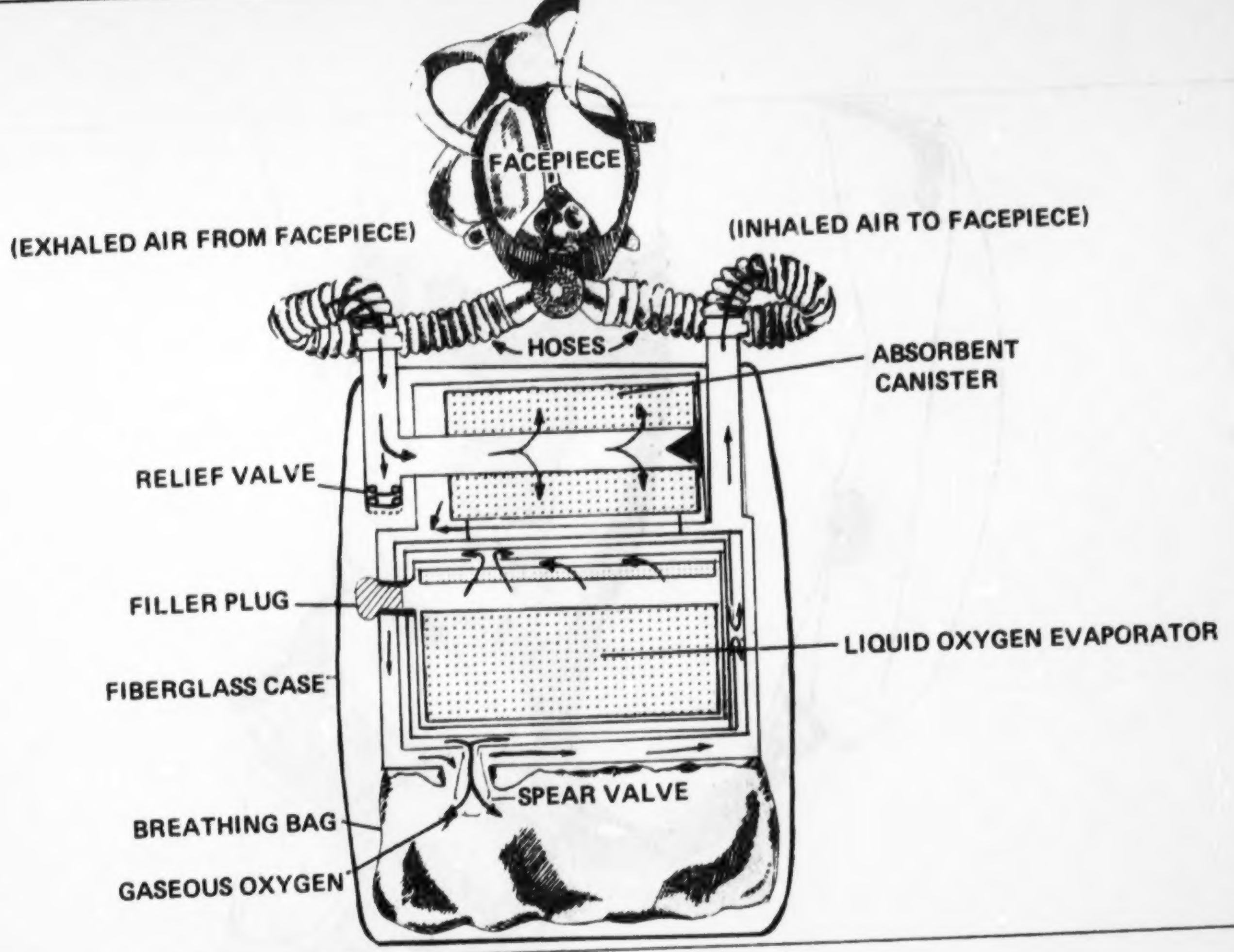
The following components should, in any event, be replaced at intervals not exceeding the following:

Inhalation and exhalation valves – 1 year
Relief valve – 1 year
Breathing bag – 2 years
Facepiece – 5 years
Breathing hoses – 5 years



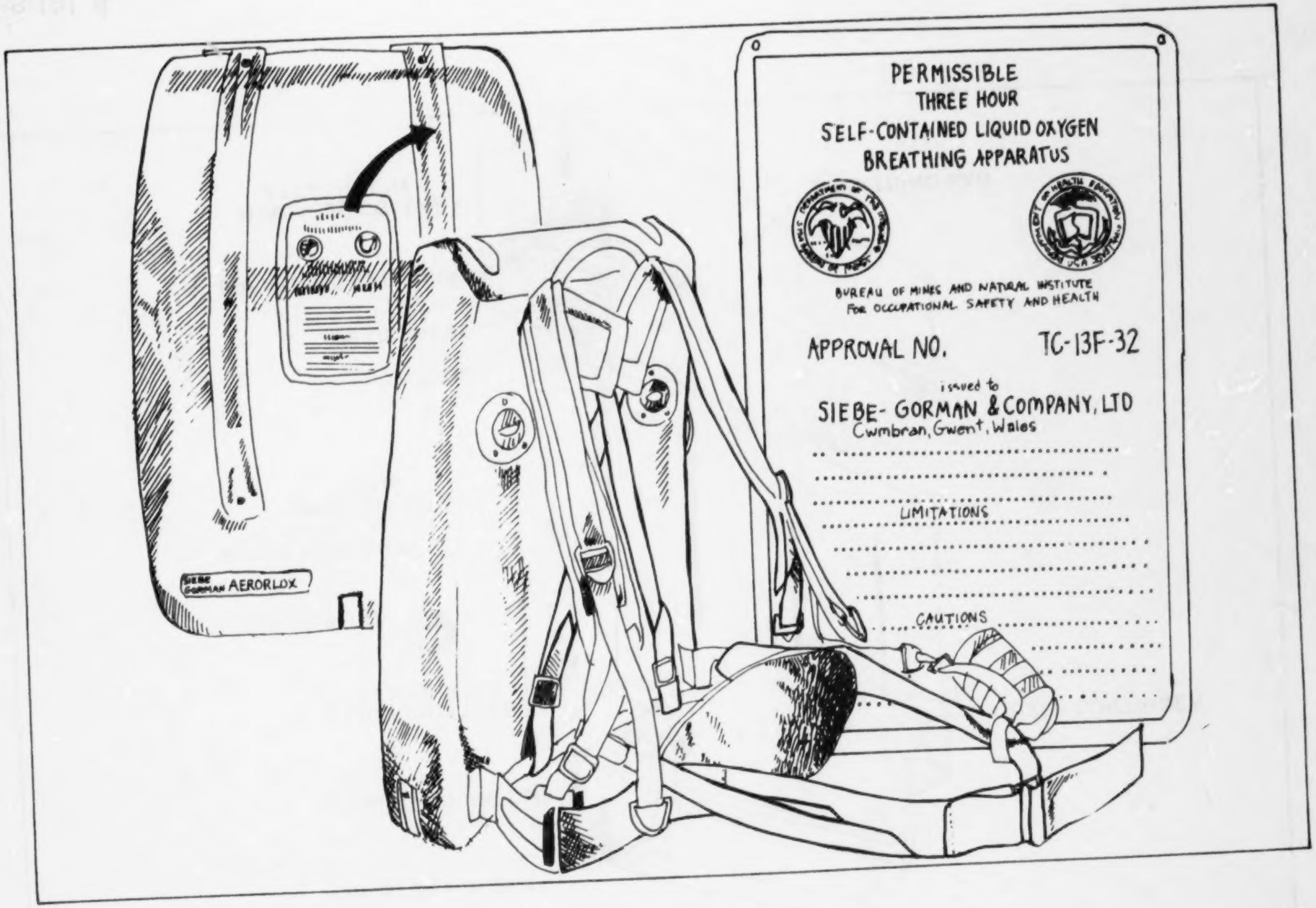
Visual 1

Aerorlox


FACEPIECE
(EXHALED AIR FROM FACEPIECE)
(INHALED AIR TO FACEPIECE)
HOSES
ABSORBENT CANISTER
RELIEF VALVE
FILLER PLUG
LIQUID OXYGEN EVAPORATOR
FIBERGLASS CASE
SPEAR VALVE
BREATHING BAG
GASEOUS OXYGEN

Cutaway of Aerorlox

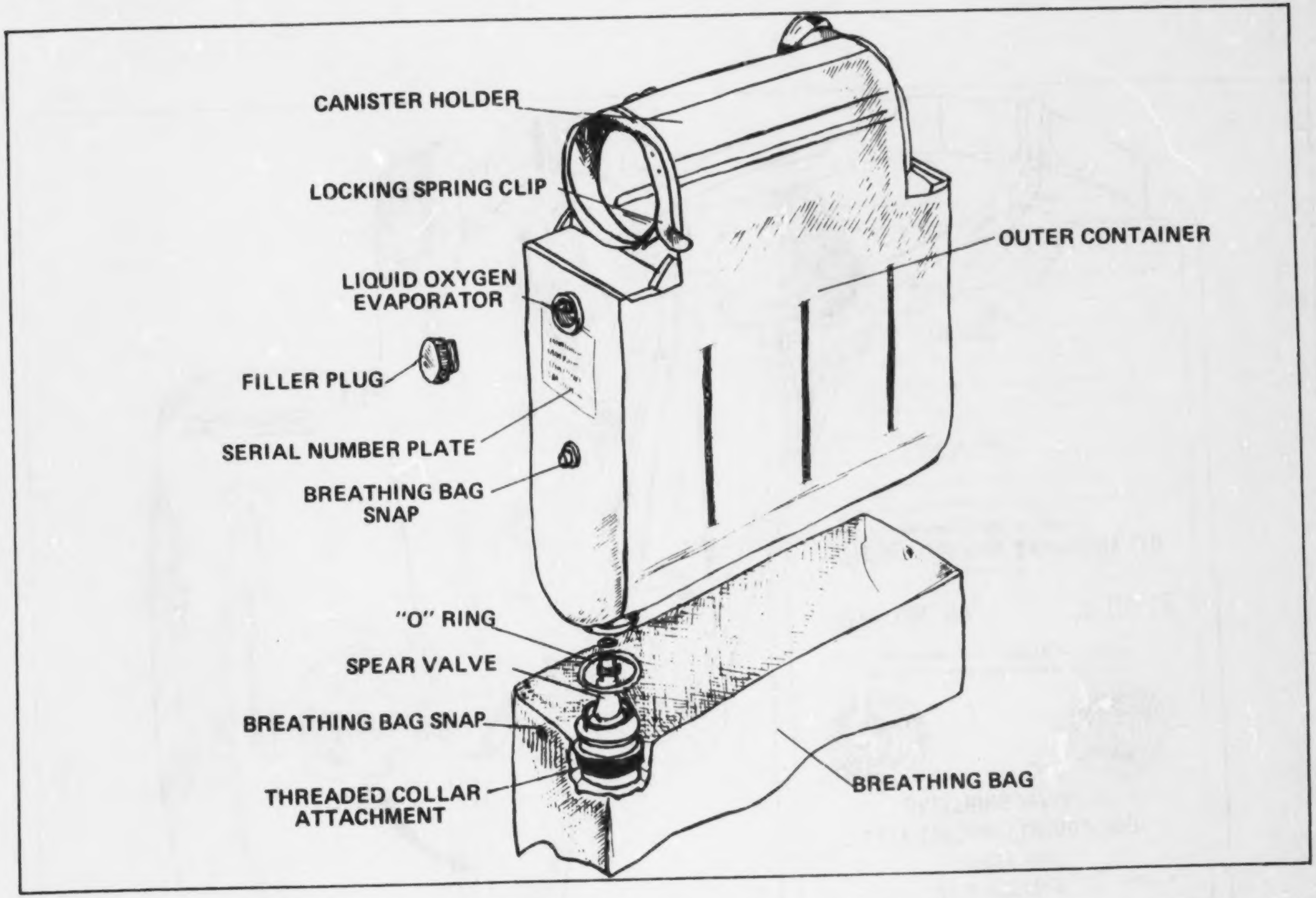
Visual 2



PERMISSIBLE
THREE HOUR
SELF-CONTAINED LIQUID OXYGEN
BREATHING APPARATUS
BUREAU OF MINES AND NATURAL INSTITUTE
FOR OCCUPATIONAL SAFETY AND HEALTH
APPROVAL NO. TC-13F-32
issued to
SIEBE- GORMAN & COMPANY, LTD
Cwmbran, Gwent, Wales
LIMITATIONS
CAUTIONS
SIEBE GORMAN AERORLOX

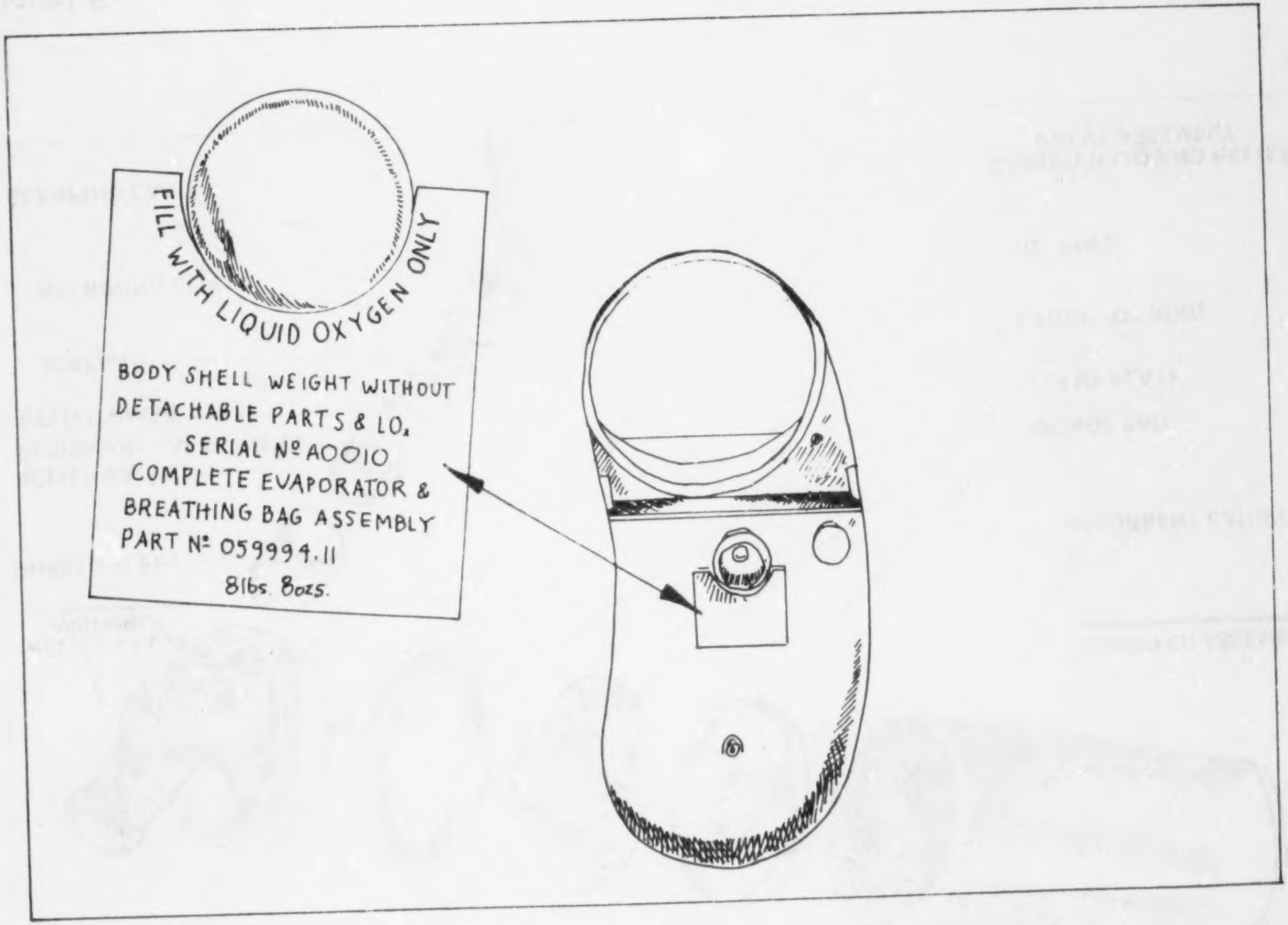
Visual 3

Protective Case and Wearing Harness


CANISTER HOLDER
LOCKING SPRING CLIP
OUTER CONTAINER
LIQUID OXYGEN EVAPORATOR
FILLER PLUG
SERIAL NUMBER PLATE
BREATHING BAG SNAP
"O" RING
SPEAR VALVE
BREATHING BAG SNAP
THREADED COLLAR ATTACHMENT
BREATHING BAG

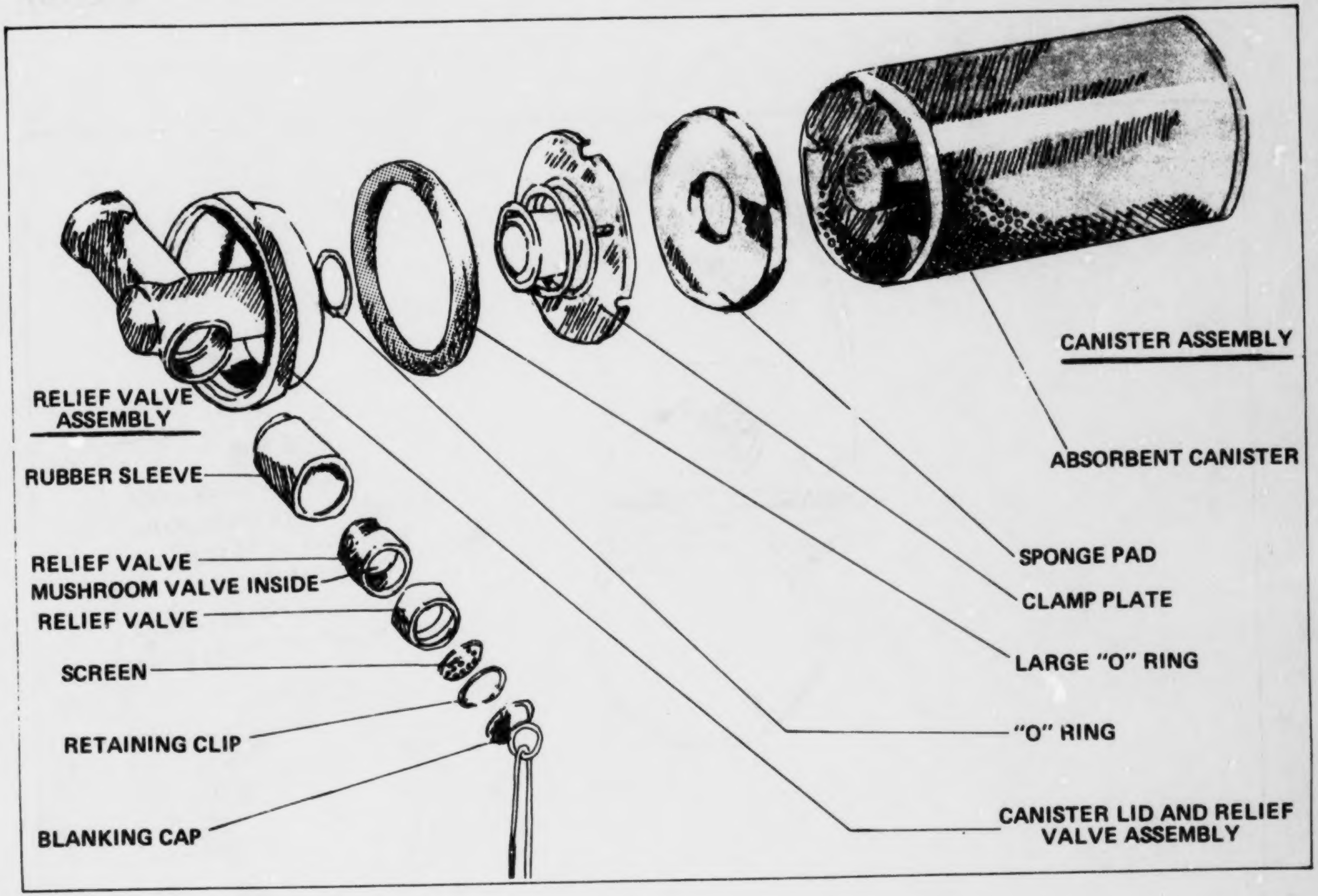
Visual 4

Outer Container and Breathing Bag

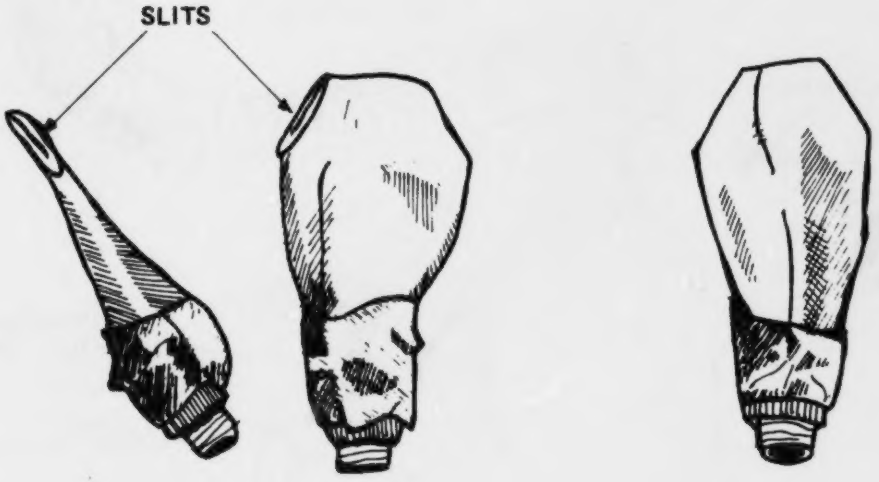

FILL WITH LIQUID OXYGEN ONLY
BODY SHELL WEIGHT WITHOUT
DETACHABLE PARTS & LO$_2$
SERIAL Nº A0010
COMPLETE EVAPORATOR &
BREATHING BAG ASSEMBLY
PART Nº 059994.11
8lbs. 8ozs.

Visual 5

Serial Number Plate

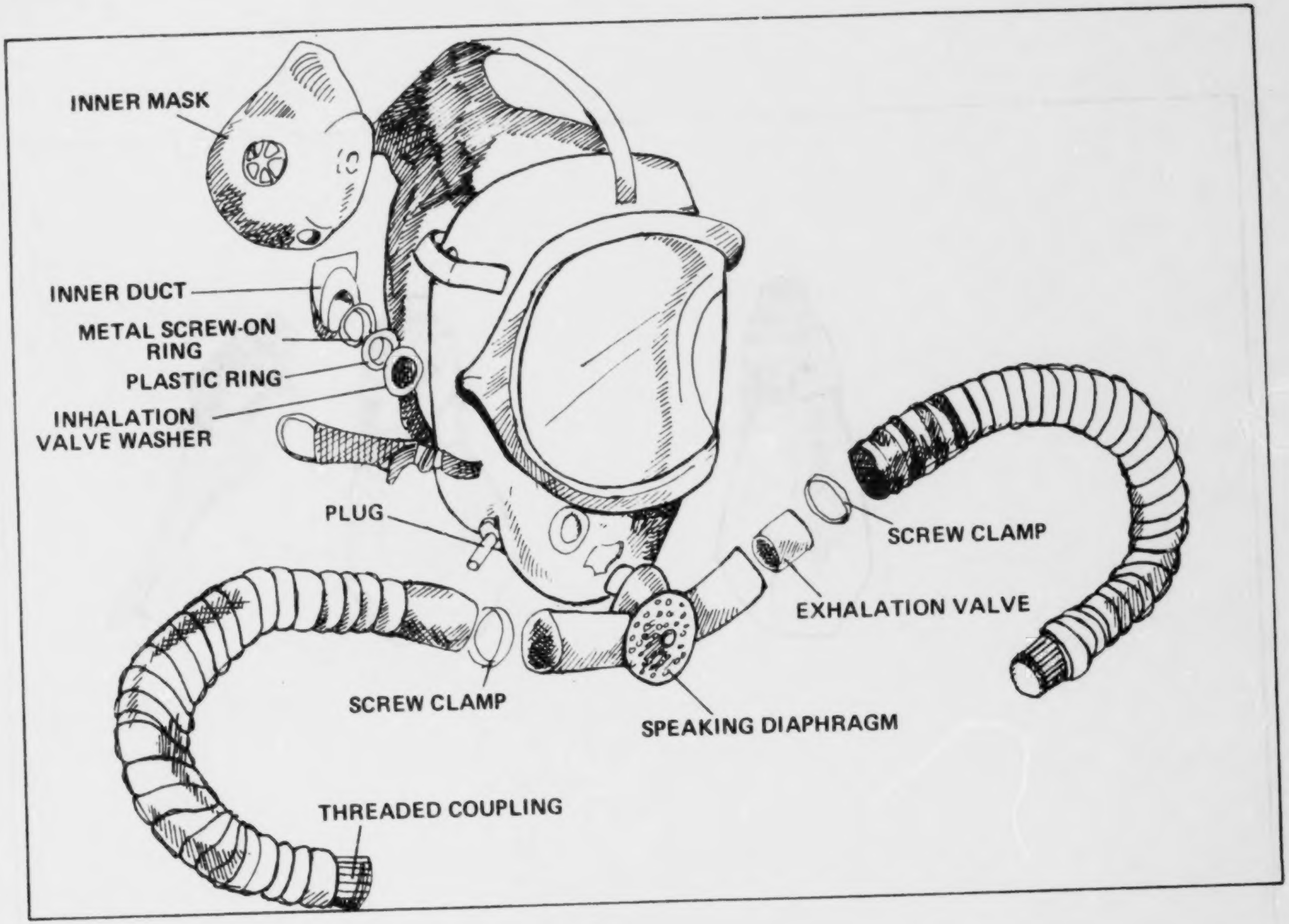

CANISTER ASSEMBLY
ABSORBENT CANISTER
SPONGE PAD
CLAMP PLATE
LARGE "O" RING
"O" RING
CANISTER LID AND RELIEF VALVE ASSEMBLY
RELIEF VALVE ASSEMBLY
RUBBER SLEEVE
RELIEF VALVE
MUSHROOM VALVE INSIDE
RELIEF VALVE
SCREEN
RETAINING CLIP
BLANKING CAP

Visual 6 Canister and Relief Valve Assembly



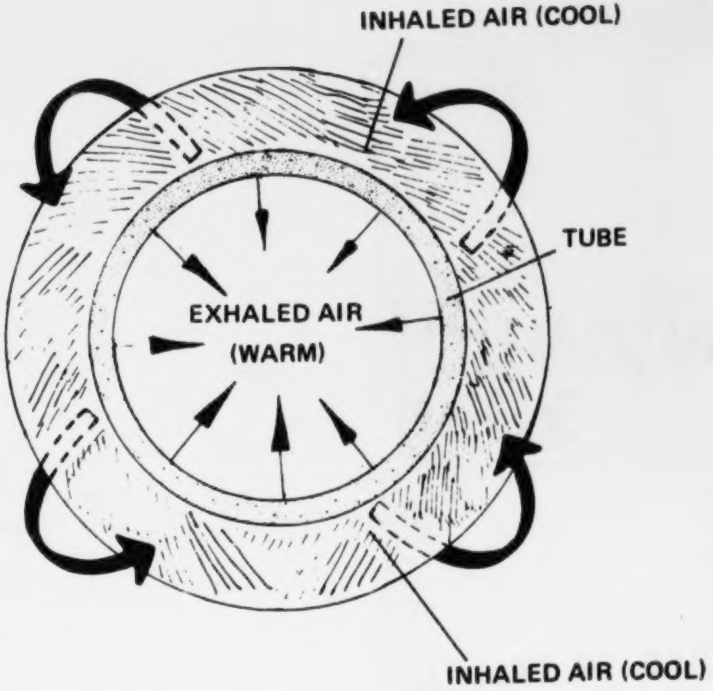
Visual 7

Spear Valve

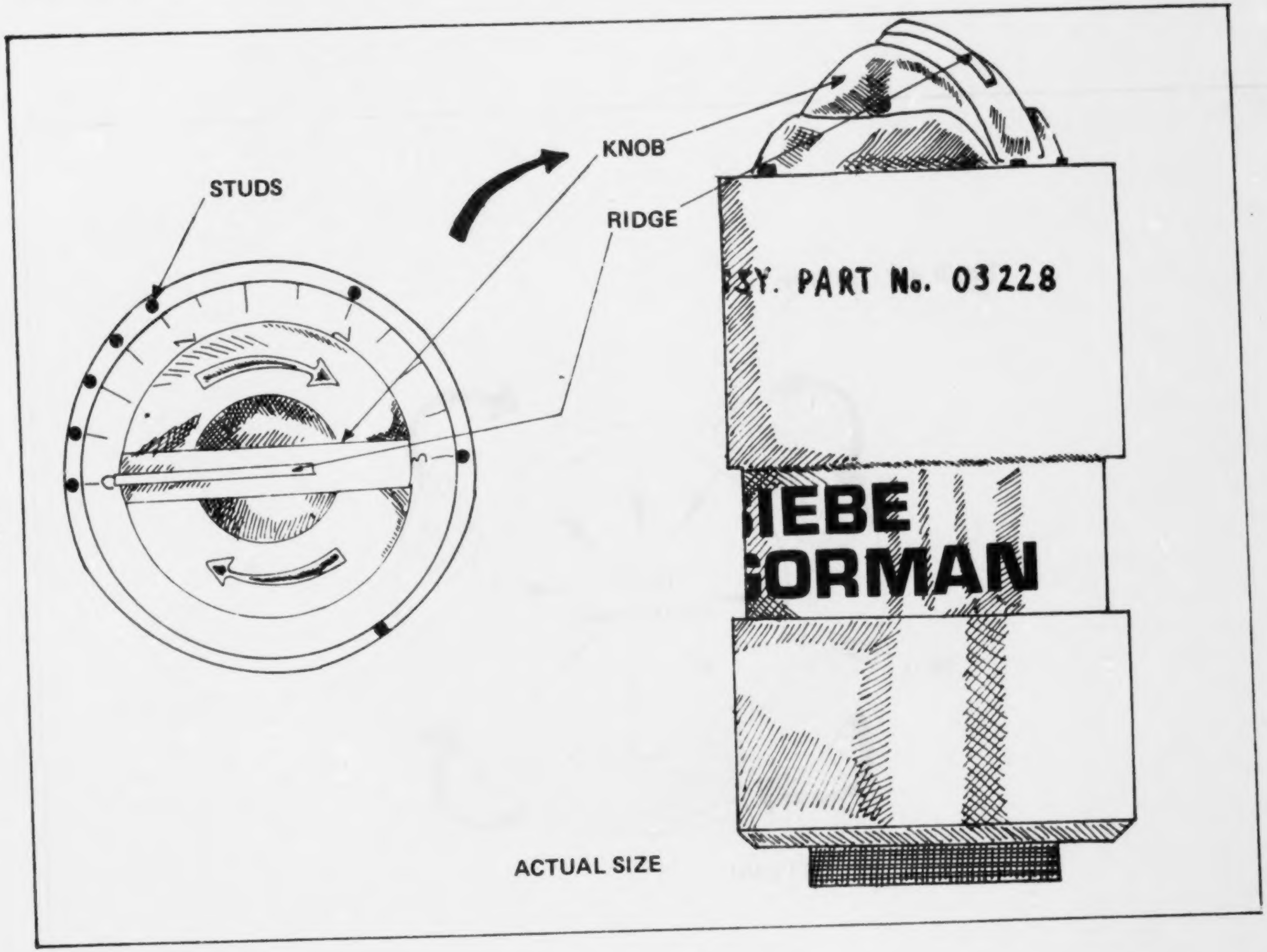

INNER MASK
INNER DUCT
METAL SCREW-ON RING
PLASTIC RING
INHALATION VALVE WASHER
PLUG
SCREW CLAMP
EXHALATION VALVE
SCREW CLAMP
SPEAKING DIAPHRAGM
THREADED COUPLING

Visual 8

Facepiece and Hoses

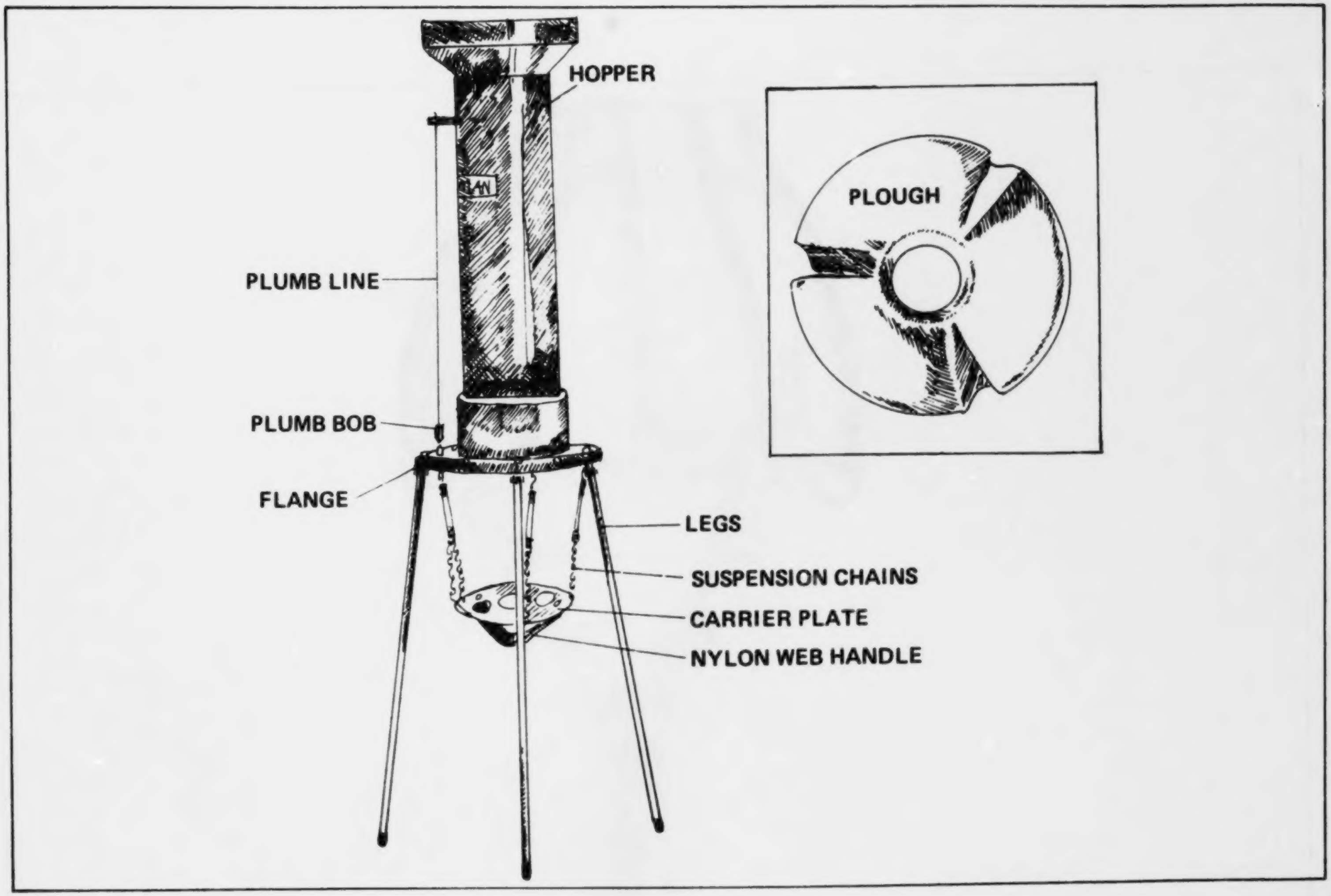

INHALED AIR (COOL)
TUBE
EXHALED AIR
(WARM)
INHALED AIR (COOL)

Visual 9 Inhalation Valve Design

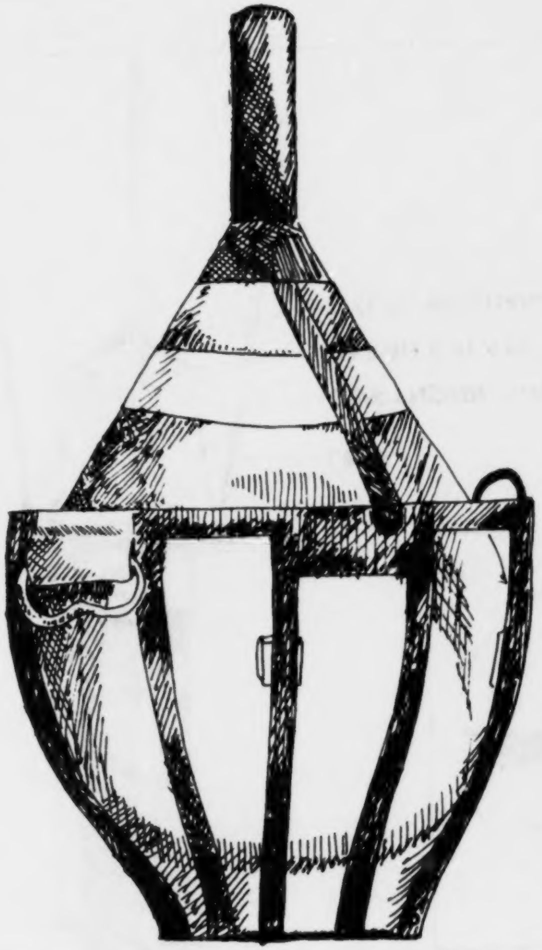

STUDS
KNOB
RIDGE
SY. PART No. 03228
IEBE
ORMAN
ACTUAL SIZE

Timer

Visual 10

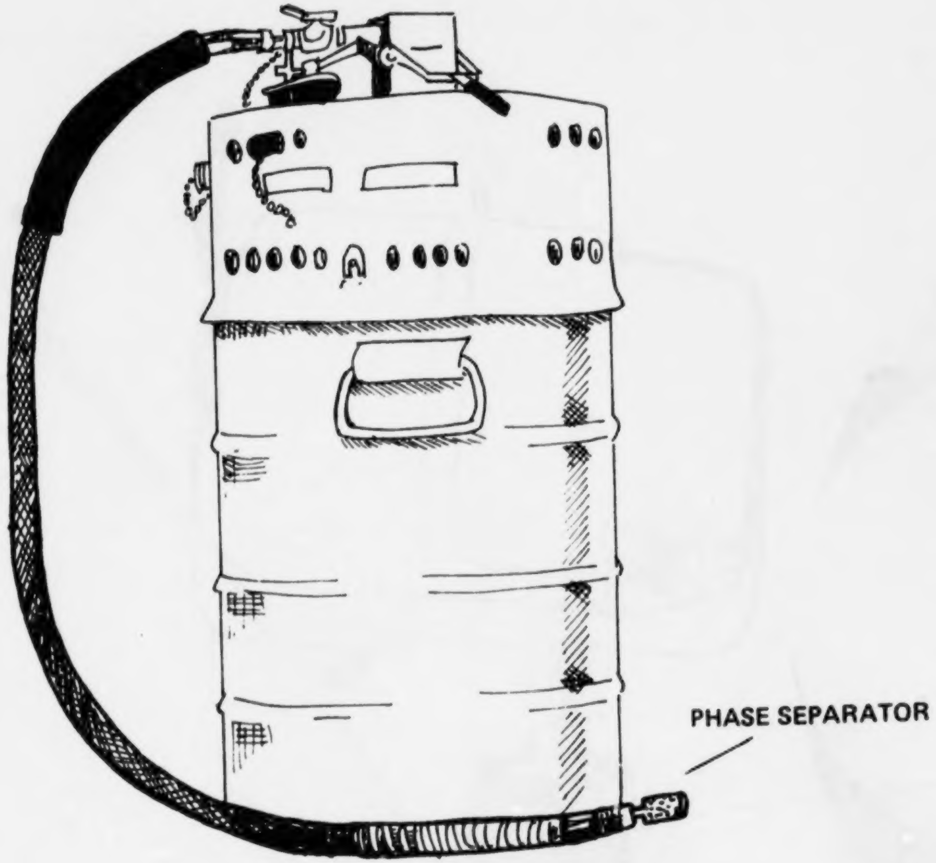

HOPPER
PLOUGH
PLUMB LINE
PLUMB BOB
FLANGE
LEGS
SUSPENSION CHAINS
CARRIER PLATE
NYLON WEB HANDLE

Visual 11 Filling Hopper and Plough



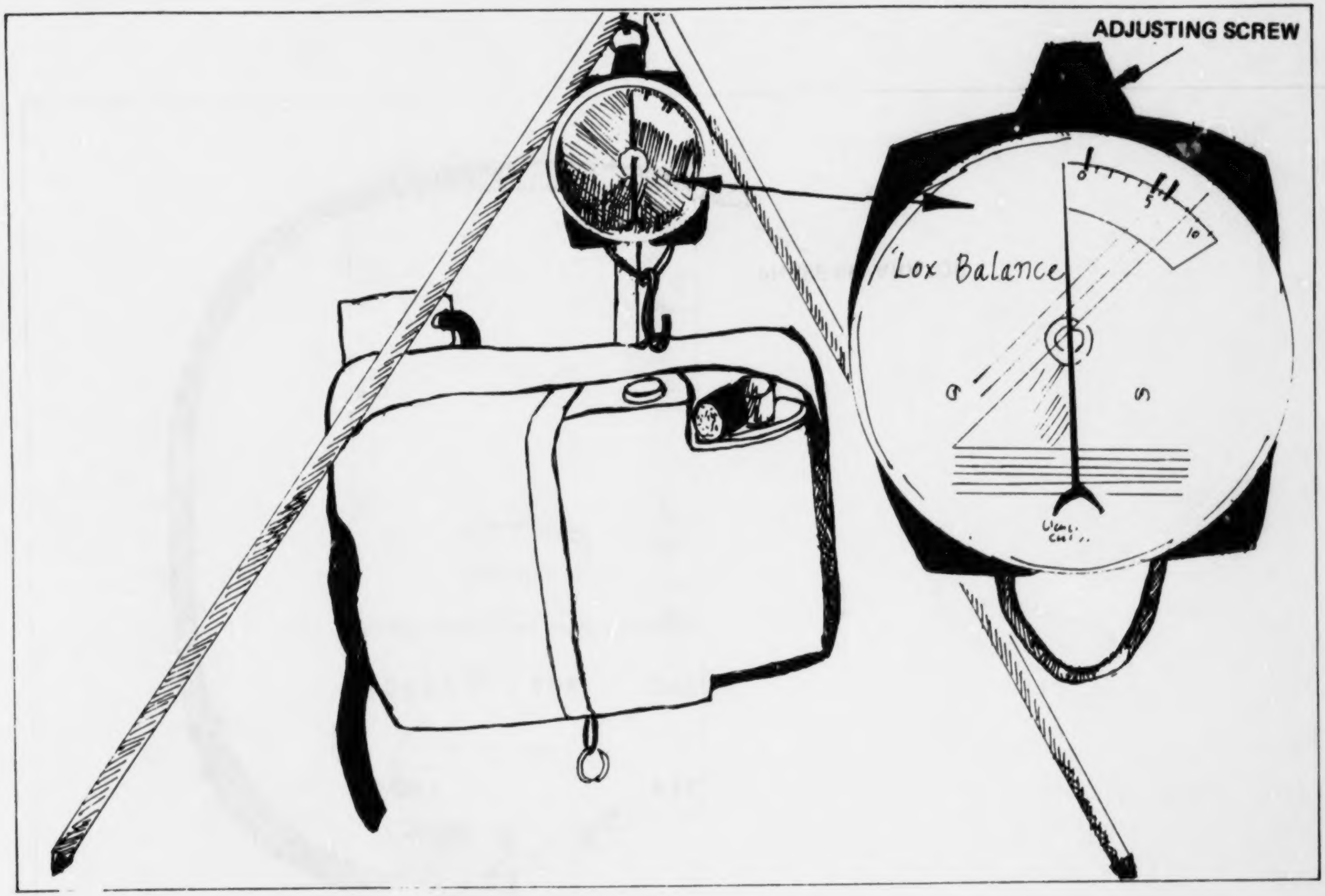
Visual 12

Dewar Flask


PHASE SEPARATOR

Visual 13

Linde Walker


ADJUSTING SCREW
'Lox Balance
0
5
10

Visual 14

Tripod and "Lox Balance"

Visual 15
Aerorlox Sample Testing Record

Unit #	**For each test below, record the date of testing and the initials of the tester.**					
Charged with Protosorb						
Visual Inspection						
Relief Valve Inward Leak Test (prior to each use)						
Complete Apparatus Leak Test (prior to each use)						
Relief Valve Pressure Test (every 30 days)						
Evaporator Leak Test (every 30 days)						
Evaporator Flow Check After Wearing (every 30 days)						
Evaporator Weight Check (every 3 months)						
Evaporator Full Flow Check (every 6 months)						

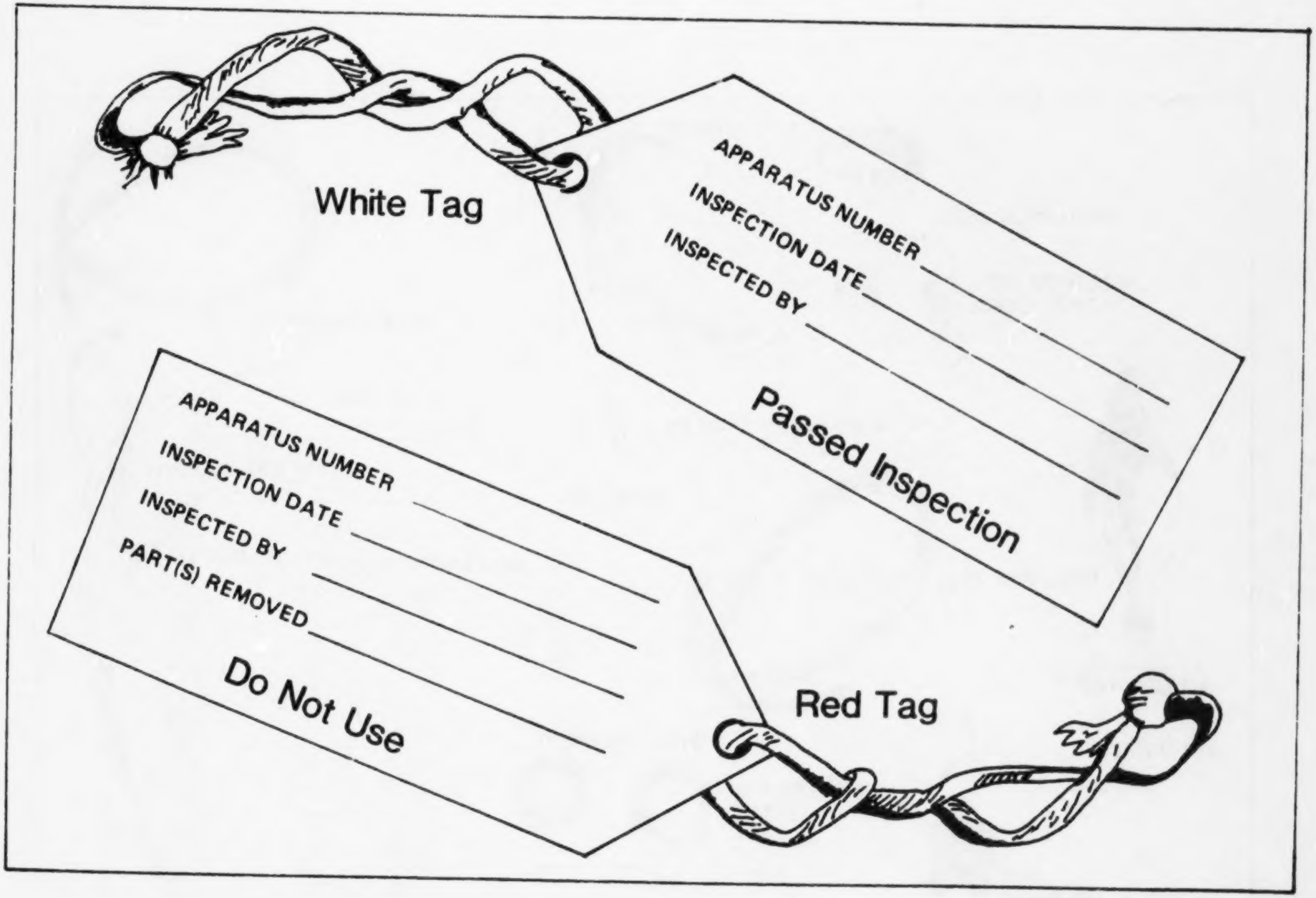
Visual 16
Aerorlox Sample Maintenance Record

Apparatus Type: ______________________ **Serial #** ______________

Apparatus # ______________________________

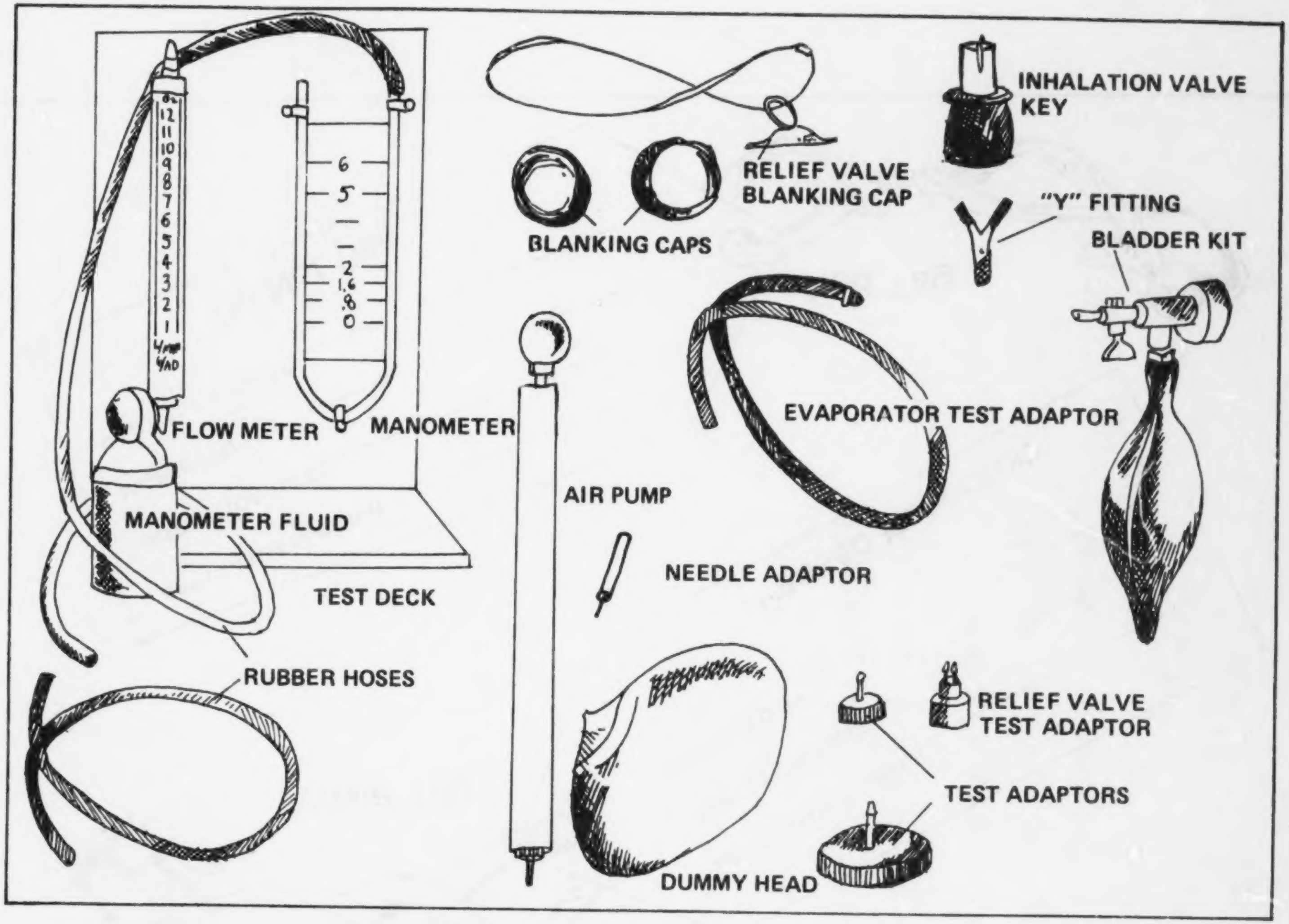
Purchase date ______________________

#Hours Used	Total Hours Used	Date Inspected	Parts Repaired or Replaced	Comments	Inspected By


White Tag
APPARATUS NUMBER
INSPECTION DATE
INSPECTED BY
Passed Inspection
APPARATUS NUMBER
INSPECTION DATE
INSPECTED BY
PART(S) REMOVED
Do Not Use
Red Tag

Visual 17

Sample Tags


FLOW METER
MANOMETER
MANOMETER FLUID
TEST DECK
RUBBER HOSES
BLANKING CAPS
RELIEF VALVE BLANKING CAP
INHALATION VALVE KEY
"Y" FITTING
BLADDER KIT
EVAPORATOR TEST ADAPTOR
AIR PUMP
NEEDLE ADAPTOR
DUMMY HEAD
RELIEF VALVE TEST ADAPTOR
TEST ADAPTORS
6
5
2
1.6
.8
0
12
11
10
9
8
7
6
5
4
3
2
1

Visual 18

Test Set

Visual 19
Testing the Aerorlox

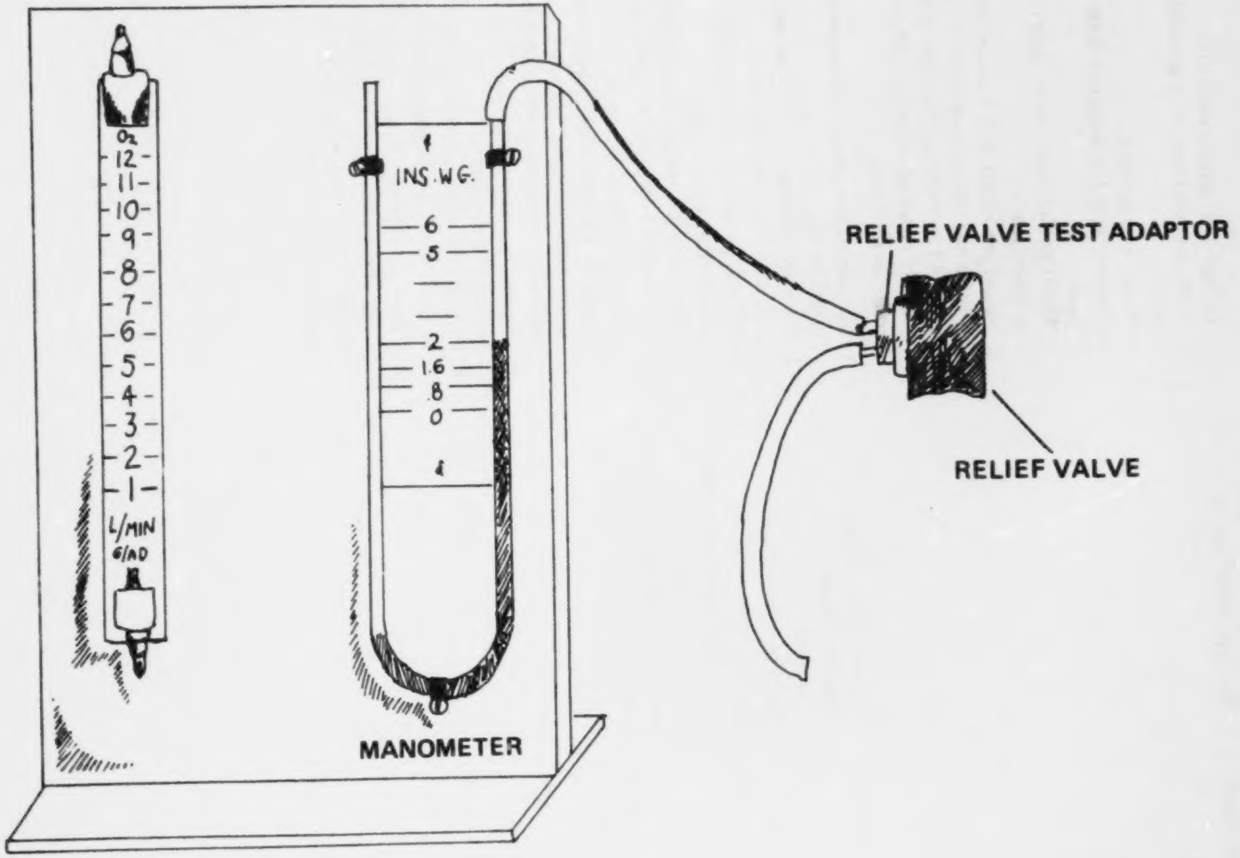
Test	Materials	Procedure Hints
1. Visual Inspection (prior to each use)		1. Check harness, case, hoses and facepiece for good condition.
2. Relief Valve Inward Leak Test (prior to each use)	1. Relief valve test adaptor 2. Manometer filled to "O" 3. Two hoses 4. Clamp for hose	1. Good Protosorb in canister? 2. Remove relief valve from canister lid and blow through it or wash it. 3. Attach relief valve test adaptor. 4. Connect one hose from right side of manometer to one outlet of test adaptor. 5. Connect other hose to other outlet of test adaptor. 6. Apply suction of 2 inches water gauge through open hose. 7. Observe fluid in column–should not fall. If it does, retest and replace if necessary.
3. Complete Apparatus Leak Test (must be done after Relief Valve Inward Leak Test) (prior to each use)	1. Dummy head inflated to 22½ inches minor circumference 2. Bladder kit 3. Gaseous oxygen 4. "Y" fitting 5. Rubber hose 6. Manometer filled to "O" 7. Sink or container filled with water	1. No liquid oxygen in evaporator. 2. Relief Valve Inward Leak Test already done? 3. Remove apparatus from case and fully assemble it (attach hoses and facepiece). Unsnap bag but leave it attached by threaded collar. 4. Check finger-tight connections. 5. Relief valve blanking cap must be in place. 6. Unscrew filler plug and screw in bladder kit. 7. Insert dummy head in facepiece and tighten straps for good seal. 8. Connect evaporator to gaseous oxygen supply and to the manometer by using hoses and the "Y" fitting. 9. Pressurize apparatus and bladder kit with gaseous oxygen to 6 inches water gauge. 10. Close tap on bladder kit and remove equipment used to inflate bladder kit. 11. Use two people to immerse apparatus in water. Press breathing bag to bottom of tank and squeeze gently. Make sure bladder remains inflated. 12. Check for air bubbles at connections. If there are leaks, remove from water, tighten all connections, check all "O" rings and retest. 13. When finished, dry off the apparatus and replace filler plug immediately.

Visual 19 (cont'd)

Test	Materials	Procedure Hints
4. Relief Valve Pressure Test (every 30 days)	1. Relief valve test adaptor 2. Manometer filled to "O" 3. Three rubber hoses 4. Auxiliary supply of air or oxygen 5. Flow meter	1. Remove relief valve from canister lid and blow through it or wash it. 2. Attach to relief valve test adaptor. 3. Connect one hose from right side of manometer to one outlet of test adaptor. 4. Connect other hose from other outlet to top of flow meter. 5. Attach third hose to bottom of flow meter. 6. Pass a flow of one LPM via the open tube, using a source of air or oxygen. 7. Listen for sound of valve opening and read manometer. 8. Manometer should read between 0.8 and 1.6 inches water gauge when relief valve opens. 9. If valve fails, retest. If it still fails, replace it.
5. Evaporator Leak Test (every 30 days)	1. Evaporator test adaptor with rubber hose 2. "Y" fitting 3. Manometer filled to "O" 4. Two hoses and a clamp 5. Gaseous oxygen	1. No liquid oxygen in evaporator. 2. Unscrew spear valve and screw in evaporator test adaptor with rubber hose. 3. Connect evaporator test adaptor hose to manometer and oxygen supply by using the "Y" fitting and hoses. 4. Pressurize the evaporator to 6 inches water gauge and pinch or clamp the oxygen hose. 5. Manometer fluid should not fall. 6. If there is a leak, check all equipment and connections and repeat the test. If it continues to leak, return for repair.
6. Evaporator Flow Check After Wearing (after 3 hour's use) (every 30 days)	1. Evaporator test adaptor 2. Flow meter	1. Apparatus worn for 3 hours. 2. Remove spear valve and screw in evaporator test adaptor with rubber hose. 3. Stand outer container on side so filler plug is uppermost. 4. Connect evaporator test adaptor hose to bottom of flow meter. 5. Reading on flow meter indicates flow rate of oxygen. Model 1.05: should be 5 LPM after 3 hours of use. Model 1.07: should be 3 LPM after 3 hours of use. 6. If flow rate is wrong, do weight check and correct if necessary. Retest. If flow rate is still wrong, return for repairs.

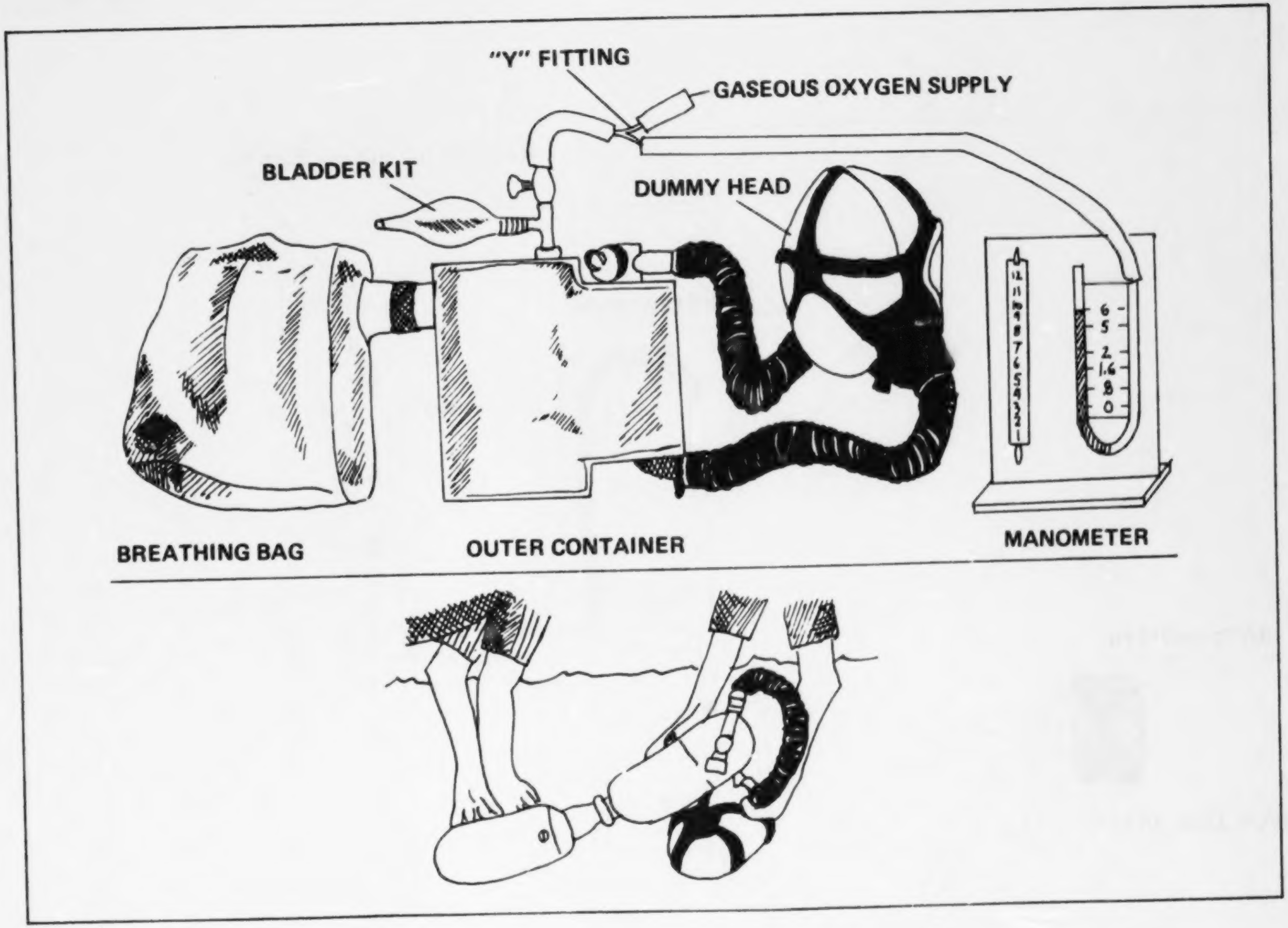
Visual 19 (cont'd)

Test	Materials	Procedure Hints
7. Evaporator Weight Check (every 3 months)	1. Flat-type weighing scale	1. No liquid oxygen in evaporator. 2. Strip outer container of all removable parts. 3. Weigh outer container. 4. Compare weight to weight on serial number plate. 5. Weight gain of more than 4 ounces–return to manufacturer. 6. Weight gain of less than 4 ounces–heat in oven to maximum temperature of 266° F (130° C) for 24 hours. Reweigh. If not within 1 ounce of original weight, return to the manufacturer.
8. Evaporator Full Flow Check (every 6 months)	1. Evaporator test adaptor with rubber hose 2. Flow meter 3. Flat-type weighing scale 4. Liquid oxygen 5. *Free Evaporation Rate Graph* (provided as visuals in the module–"Visual 25" for 1.05 model, and "Visual 26" for 1.07 model)	1. Remove protective case and disconnect breathing bag. 2. Set outer container on flat-type weighing scale with filler plug uppermost. 3. Fill with 6.5 pounds of liquid oxygen and quickly replace filler plug. 4. Distribute liquid oxygen in evaporator–hold upright 5 seconds, on filler plug side 5 seconds, hold upright again. 5. Lay on its side with filler plug uppermost. 6. Remove spear valve and screw in evaporator test adaptor with rubber hose. 7. Connect evaporator test adaptor hose to bottom of flow meter. 8. Compare flow rate registering on flow meter with Aerorlox *Free Evaporation Rate Graph*. 9. If flow rate is wrong, do an evaporator weight check and correct if necessary. Retest. If still wrong, return to the manufacturer.


O2
12
11
10
9
8
7
6
5
4
3
2
1
L/MIN
6/AD
INS.W.G.
6
5
2
1.6
.8
0
MANOMETER
RELIEF VALVE TEST ADAPTOR
RELIEF VALVE

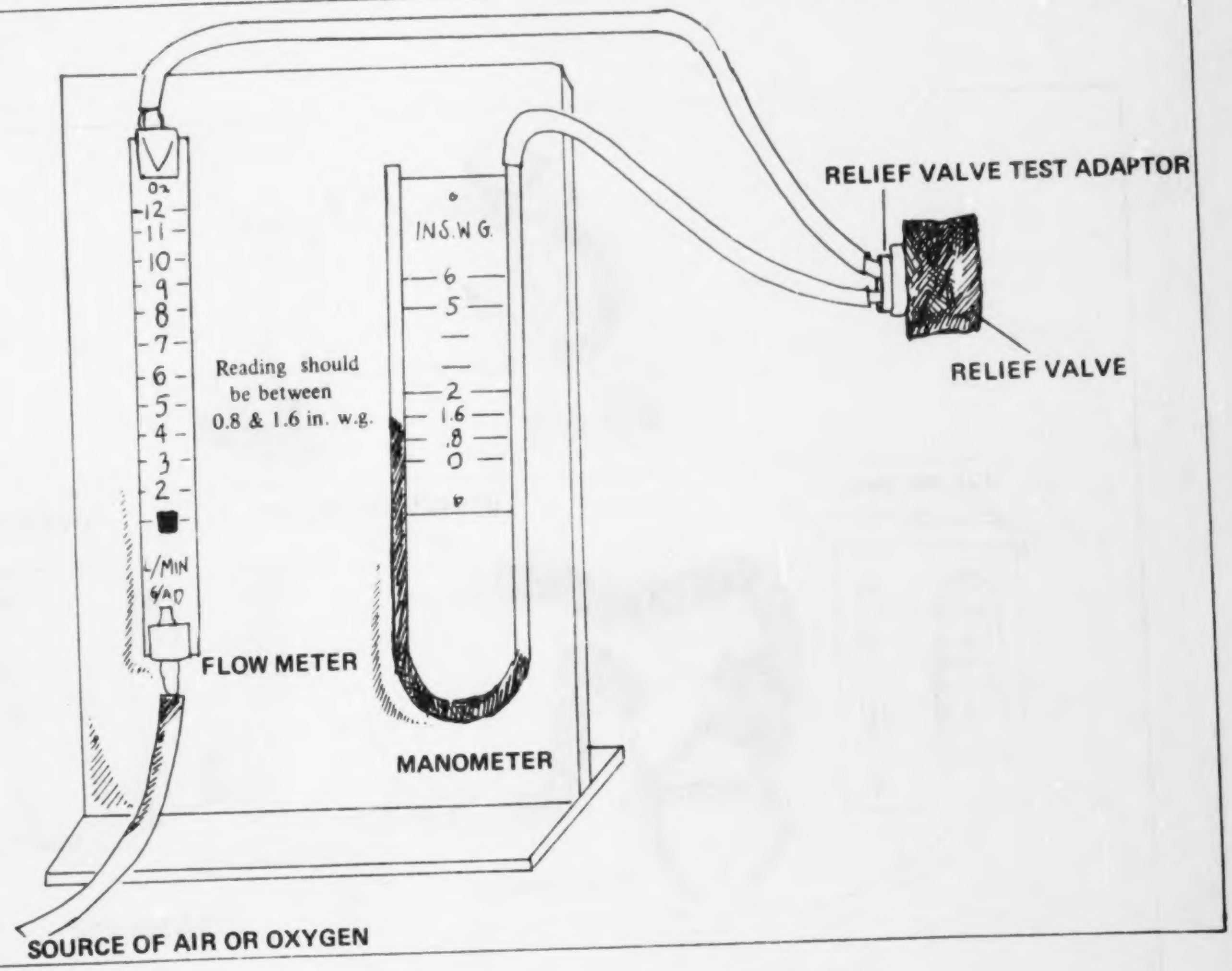
Visual 20

Relief Valve Inward Leak Test


"Y" FITTING
GASEOUS OXYGEN SUPPLY
BLADDER KIT
DUMMY HEAD
6
5
2
1.6
.8
0
BREATHING BAG
OUTER CONTAINER
MANOMETER

Visual 21

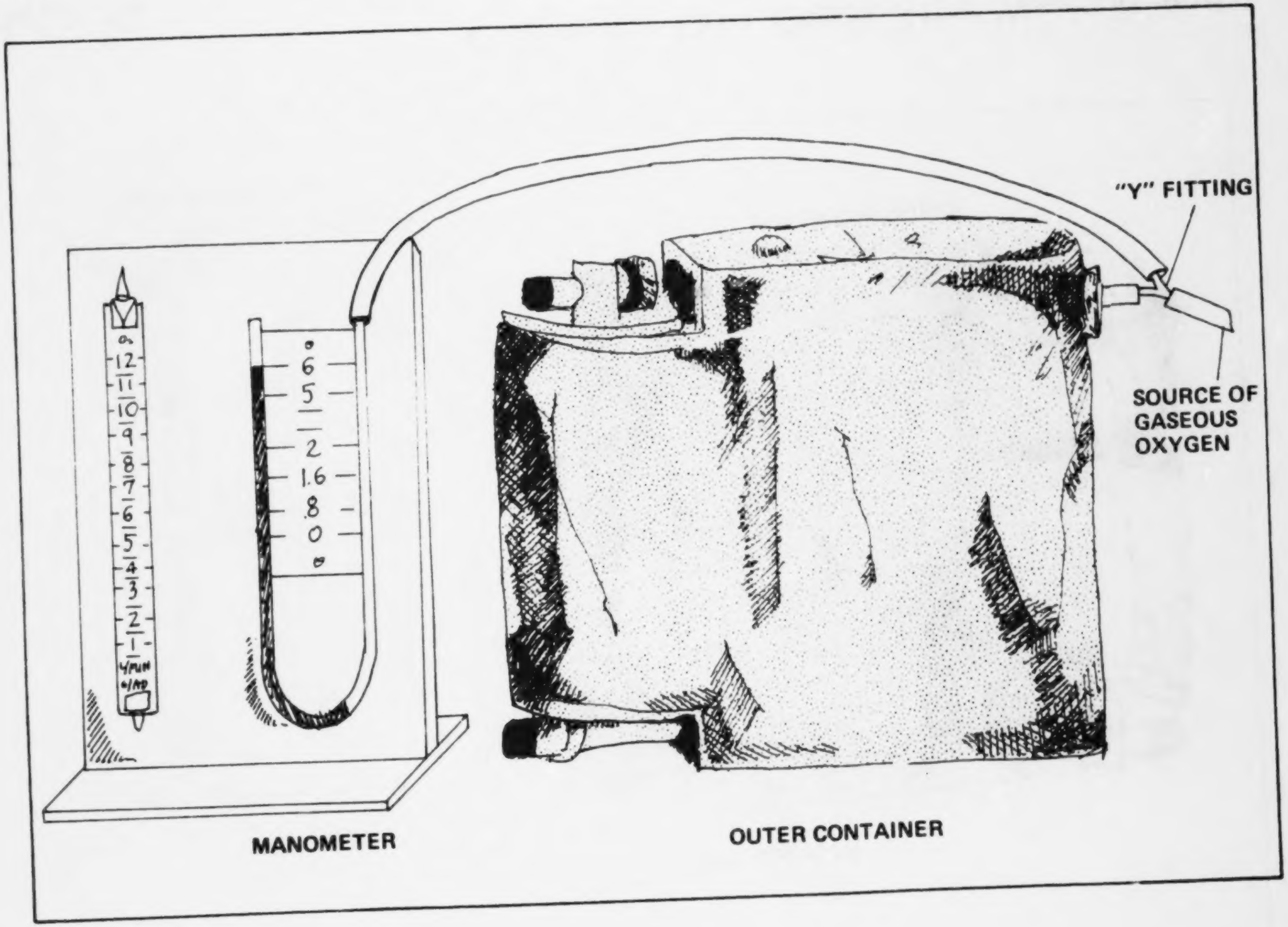
Complete Apparatus Leak Test


RELIEF VALVE TEST ADAPTOR
RELIEF VALVE
O2
12
11
10
9
8
7
6
5
4
3
2
L/MIN
FLOW METER
INS.W.G.
6
5
2
1.6
.8
0
MANOMETER
SOURCE OF AIR OR OXYGEN

Reading should be between 0.8 & 1.6 in. w.g.

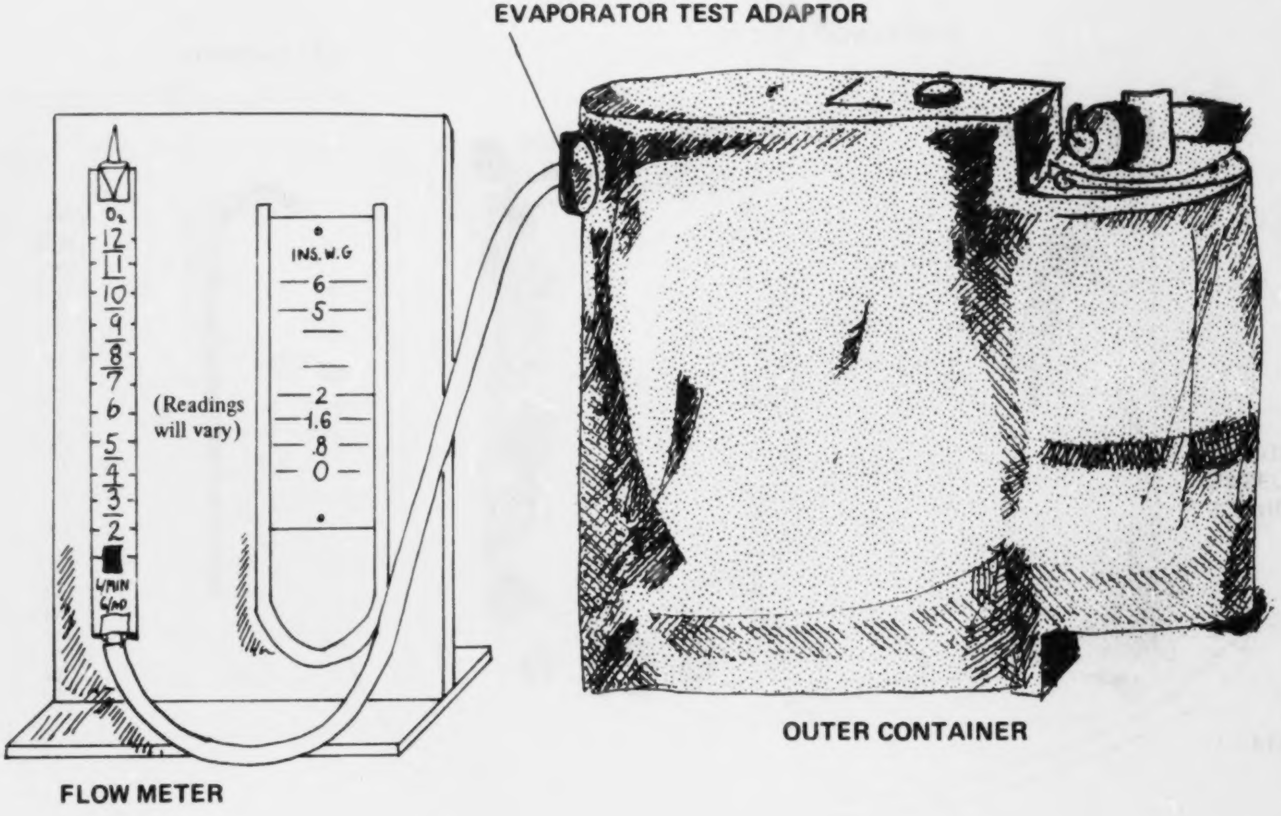
Relief Valve Pressure Test

Visual 22


"Y" FITTING
SOURCE OF GASEOUS OXYGEN
MANOMETER
OUTER CONTAINER
12 11 10 9 8 7 6 5 4 3 2 1
6 5 2 1.6 .8 0

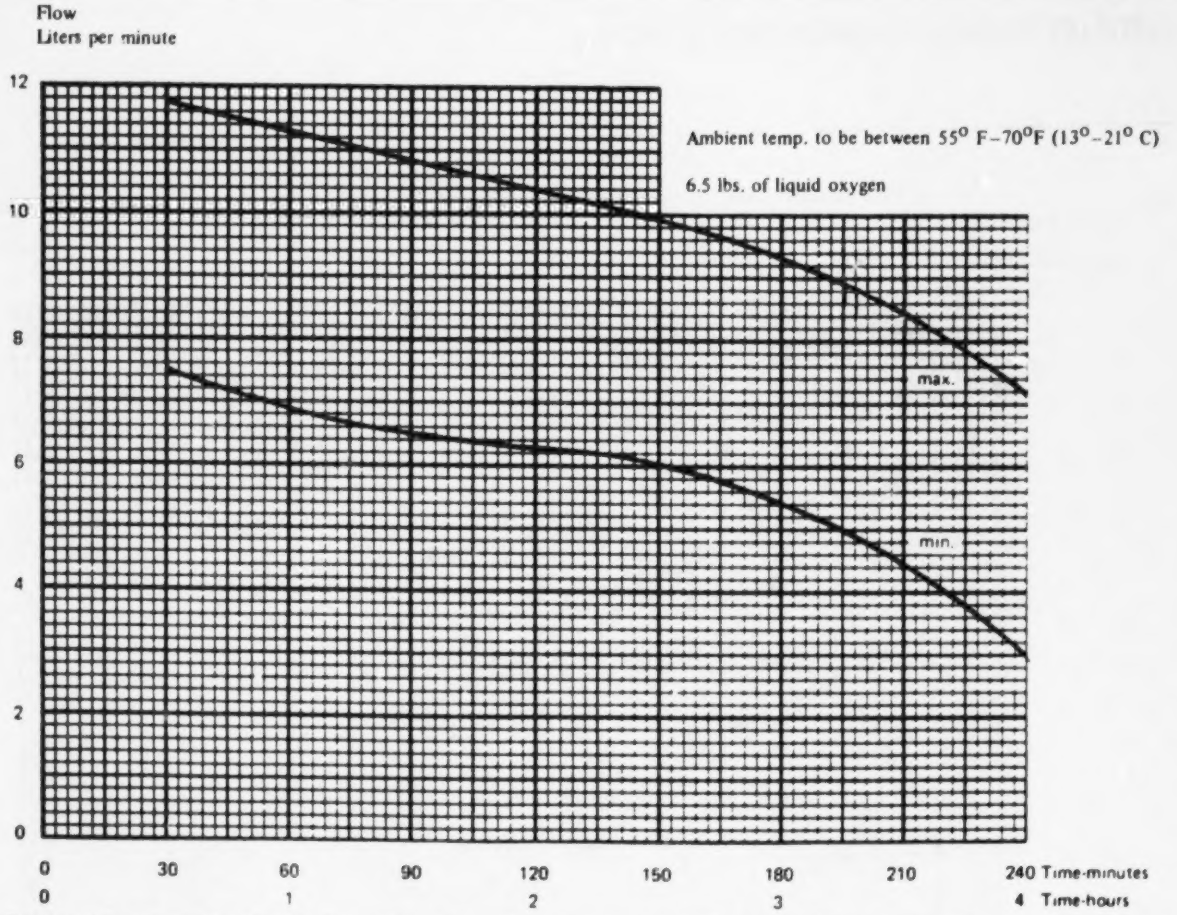
Visual 23

Evaporator Leak Test


EVAPORATOR TEST ADAPTOR
O2
12
11
10
9
8
7
6
5
4
3
2
L/MIN
G/MO
INS. W.G
6
5
2
1.6
.8
0
(Readings will vary)
OUTER CONTAINER
FLOW METER

Visual 24

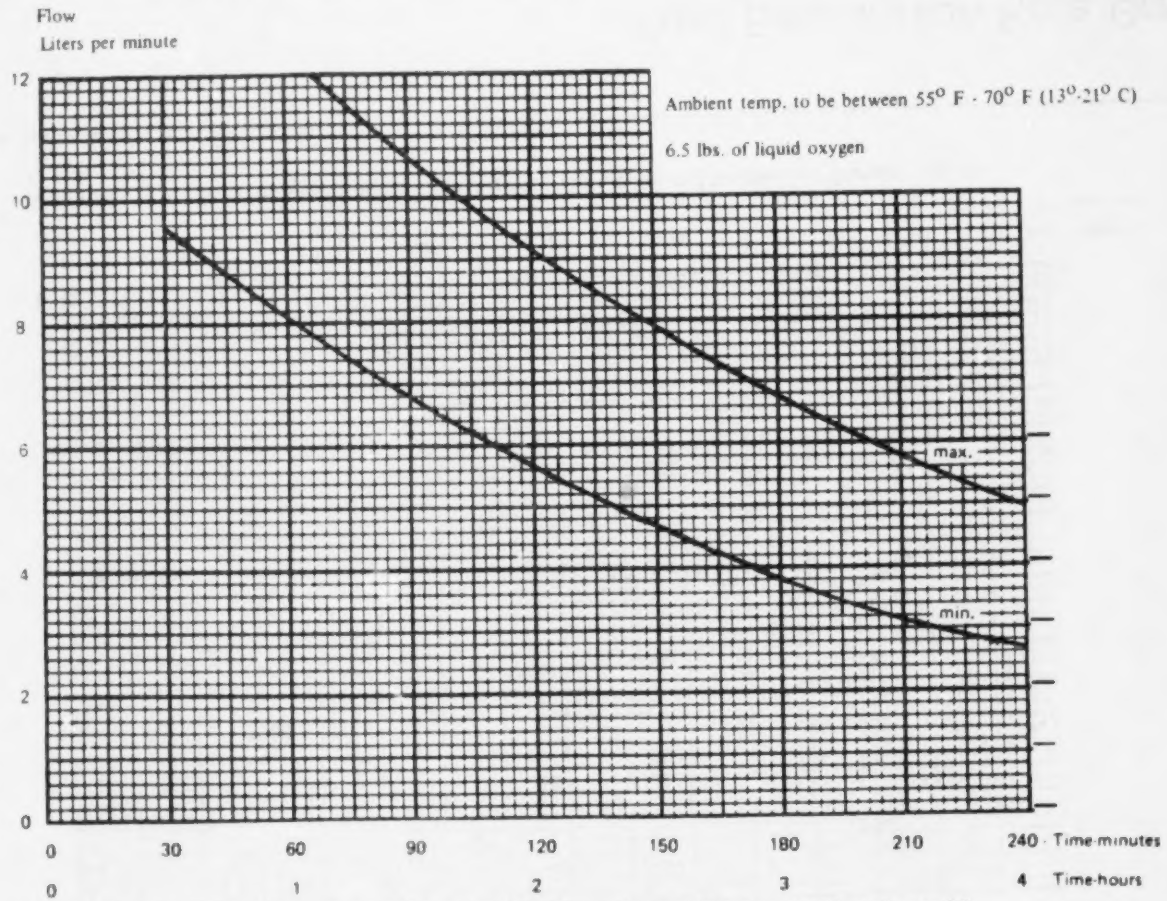
Evaporator Flow Check After Wearing, and Evaporator Full Flow Check



Reprinted by permission of Siebe Gorman from *Aerorlox Instruction and Maintenance Manual*, page 16.

Visual 25

Free Evaporation Rate Graph
for Aerorlox Model 013831.05 (1.05)



Ambient temp. to be between 55° F · 70° F (13°-21° C)

6.5 lbs. of liquid oxygen

Reprinted by permission of Siebe Gorman from *Aerorlox Instruction and Maintenance Manual*, page 16.

Visual 26

Free Evaporation Rate Graph
for Aerorlox Model 013831.07 (1.07)

Visual 27
Aerorlox Suggested Preventive Maintenance Schedule

Every 2 months	Inspect, and replace as necessary: (1) All components, especially rubber parts. (2) Inhalation valve, especially valve washer. (3) Exhalation valve, especially mushroom component (do not disassemble the valve). (4) Relief valve, especially mushroom components.
Every 3 months, or after 30 operational sessions (whichever is sooner)	Replace timer battery.
Every year	Replace inhalation and exhalation valves. Replace relief valve.
Every 2 years	Replace breathing bag.
Every 5 years	Replace facepiece. Replace breathing hoses.

Demonstration Check 1
PUTTING ON AND TAKING OFF THE AERORLOX

Person's name ______________________________

Instruct each team member to demonstrate the proper method of putting on and taking off the Aerorlox. Watch closely as the team member goes through the demonstration. Use this checklist below to record the performance.

Putting On the Aerorlox

Did the person:

	Yes	No
1. Make sure the relief valve blanking cap is off and timer is set?	___	___
2. Visually inspect the protective case, harness, and hoses?	___	___
3. Visually examine facepiece? (Inflate inflatable seal, if necessary?)	___	___
4. Properly connect the hoses to the apparatus?	___	___
5. Properly put on the apparatus (with facepiece out of the way) and adjust for a good fit?	___	___
6. Put on the facepiece correctly?	___	___
7. Check the facepiece seal?	___	___
8. Check the inhalation and exhalation valves?	___	___

Taking Off the Aerorlox

Did the person:

1. Remove the facepiece correctly?	___	___
2. Properly take off the apparatus (with the facepiece out of the way)?	___	___

Demonstration Check 2

TAKING APART, CLEANING, AND REASSEMBLING THE AERORLOX

Person's name ______________________________

Instruct each team member to demonstrate the proper method of cleaning, disinfecting, and reassembling the Aerorlox. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Removing the Exposed Parts

Did the person:

	Yes	No
1. Make sure the liquid oxygen was fully evaporated?	___	___
2. Remove the protective case correctly?	___	___
3. Disconnect the hoses and breathing bag from the apparatus and pour out the water from the bag?	___	___
4. Remove the absorbent canister and throw out the Protosorb? Brush away any loose particles of Protosorb in the canister?	___	___
5. Remove the spear valve and screw in the evaporator test adaptor with the rubber hose? Seal the hose with a plug or clamp?	___	___

Cleaning/Disinfecting and Drying the Parts

(Note: It is not necessary for the team member to actually wash, rinse, and dry the parts. Have the person "go through the motions," so to speak, telling you how to properly wash, rinse, and dry the parts.)

Did the person:

	Yes	No
1. Rinse all the parts in clean water before washing them in a cleansing/disinfecting solution containing one part "Flordol" to 40 parts water? (Parts: Canister assembly–clean components only if moist Facepiece and hoses–fully assembled Outer container assembly Breathing bag Spear valve Canister lid Relief valve assembly–fully assembled)	___	___
2. Thoroughly rinse all the washed parts in clean water?	___	___
3. Properly and thoroughly dry the parts? (leaving evaporator test adaptor in place until everything is dry?)	___	___
4. Wipe inside of facepiece lens with "Antidim"-moistened cloth when facepiece is dry?	___	___

Reassembling the Apparatus

Did the person:

	Yes	No
1. Remove evaporator test adaptor and replace the spear valve, checking it for good condition?	___	___
2. Attach the breathing bag correctly?	___	___
3. Check all "O" rings on the canister lid and canister holder and wipe them with a clean damp cloth to remove any Protosorb?	___	___
4. Optional: Apply lubricant to large "O" ring on canister lid?	___	___
5. Properly reassemble the canister assembly, checking to see that centralizing cone is in place and in good condition before inserting canister in holder?	___	___
6. Properly reassemble the relief valve if taken apart for faster drying?	___	___
7. Correctly replace the canister lid?	___	___
8. Correctly replace the apparatus in the protective case?	___	___

Demonstration Check 3

PREUSE TESTING–
RELIEF VALVE INWARD LEAK TEST
COMPLETE APPARATUS LEAK TEST

Person's name ________________________________

Instruct each team member to demonstrate the proper method of performing each of the following tests. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance. These tests must be done in order.

Relief Valve Inward Leak Test

Did the person:

	Yes	No
1. Check to see if Protosorb is good, or fill the canister with Protosorb?	___	___
2. Remove the relief valve from the canister lid and blow through it or wash it to ensure it is clean and moist?	___	___
3. Properly connect the relief valve test adaptor and hoses to the relief valve and manometer?	___	___
4. Apply a suction of 2 inches water gauge by gently sucking on the open end of hose?	___	___
5. Pinch or clamp the hose at 2 inches water gauge, and observe the manometer reading to make sure the fluid does not fall?	___	___
6. If the fluid falls: Repeat the procedure, starting with Step 2, and replace if necessary?	___	___

Complete Apparatus Leak Test

Did the person:

	Yes	No
1. Do the Relief Valve Inward Leak Test first?	___	___
2. Make sure there is no liquid oxygen in the evaporator?	___	___
3. Remove the apparatus from the case and fully assemble it, leaving breathing bag unsnapped but attached by threaded collar?	___	___
4. Check finger-tight connections and make sure relief valve blanking cap is on?	___	___
5. Remove filler plug and screw in bladder kit?	___	___
6. Seal mask with inflated dummy head (minor circumference of about 22½ inches)?	___	___

		Yes	No
7.	Properly connect bladder kit to the manometer and source of gaseous oxygen by using the "Y" fitting and rubber hoses?	___	___
8.	Pressurize apparatus and bladder kit to 6 inches water gauge, close the tap, and disconnect all the equipment used to inflate bladder kit?	___	___
9.	Using two people, immerse the apparatus in water, gently squeezing the breathing bag at the bottom of the tank or sink, and making sure bladder remains inflated?	___	___
10.	Check for air bubbles at connections?	___	___
11.	If there are leaks: Remove apparatus from water, tighten connections, check "O" rings, and retest?	___	___
12.	Completely dry the apparatus when finished, and immediately replace filler plug after removing bladder kit?	___	___

Demonstration Check 4
RELIEF VALVE PRESSURE TEST

Person's name ______________________

Instruct each team member to demonstrate the proper method of performing the following test. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Did the person:

	Yes	No
1. Remove the relief valve from the canister lid and blow through it or wash it to ensure it is clean and moist?	____	____
2. Attach the relief valve test adaptor to relief valve?	____	____
3. Properly connect all three hoses to the test adaptor, manometer, and flow meter?	____	____
4. Pass a flow of 1 LPM through the bottom hose of flow meter using a source of air or oxygen?	____	____
5. Listen for relief valve to open between 0.8 and 1.6 inches water gauge?	____	____
6. If the valve doesn't open between 0.8 and 1.6: Repeat the test, starting with Step 1 and replace if necessary?	____	____

Demonstration Check 5
EVAPORATOR LEAK TEST

Person's name ___________________

Instruct each team member to demonstrate the proper method of performing the following test. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Did the person:	Yes	No
1. Make sure there is no liquid oxygen in the evaporator?	___	___
2. Unscrew spear valve and screw in evaporator test adaptor with rubber hose?	___	___
3. Properly use the "Y" fitting and the hoses to connect the evaporator test adaptor hose to the manometer and oxygen supply?	___	___
4. Pressurize the evaporator with gaseous oxygen to 6 inches water gauge, and pinch or clamp the oxygen hose to create a seal?	___	___
5. Observe manometer to see if fluid falls?	___	___
6. If fluid does fall: Check all equipment and connections and retest? Return for repair, if necessary?	___	___

Demonstration Check 6
EVAPORATOR FLOW CHECK AFTER WEARING

Person's name ______________________________

Instruct each team member to demonstrate the proper method of performing the following test. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Did the person:

	Yes	No
1. Test the apparatus after it had been worn for 3 hours?	___	___
2. Remove the spear valve and screw in evaporator test adaptor with rubber hose?	___	___
3. Stand outer container on its side so that filler plug is uppermost?	___	___
4. Connect evaporator test adaptor hose to bottom of flow meter?	___	___
5. Observe the flow meter? Should be: 5 LPM for Model 1.05 (after 3 hour's use) 3 LPM for Model 1.07 (after 3 hour's use)	___	___
6. If flow rate is wrong: Perform evaporator weight check and correct weight if necessary? Retest? Return for repairs?	___	___

Demonstration Check 7
EVAPORATOR WEIGHT CHECK

Person's name ______________________________

Instruct each team member to demonstrate the proper method of performing the following test. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Did the person:

	Yes	No
1. Make sure there is no liquid oxygen in evaporator?	___	___
2. Strip the outer container of all removable parts?	___	___
3. Weigh the outer container and compare weight to the weight engraved on serial number plate?	___	___
4. Correct the weight, if necessary?	___	___

Weight gain of more than 4 ounces: Return to manufacturer.

Weight gain of less than 4 ounces: Heat in an oven to maximum temperature of 266° F (130° C) for 24 hours. Reweigh. If not within 1 ounce, return to manufacturer.

Demonstration Check 8
EVAPORATOR FULL FLOW CHECK

Person's name ______________________________

Instruct each team member to demonstrate the proper method of performing the following test. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Did the person:

	Yes	No
1. Remove the protective case and disconnect breathing bag?	___	___
2. Place the outer container on a weighing scale such that filler plug is at top, and properly fill the evaporator with 6.5 pounds of liquid oxygen?	___	___
3. Replace the filler plug immediately after filling?	___	___
4. Properly distribute the liquid oxygen within the evaporator? Hold upright 5 seconds; hold sideways with filler plug lowermost 5 seconds; hold upright 5 seconds; and set down sideways with filler plug uppermost.	___	___
5. Remove spear valve and screw in evaporator test adaptor with rubber hose?	___	___
6. Connect evaporator test adaptor hose to bottom of flow meter?	___	___
7. Compare flow rate of oxygen to the acceptable rate given on the *Free Evaporation Rate Graph* ("Visual 25" for Model 1.05; "Visual 26" for Model 1.07)?	___	___
8. If flow rate is wrong: Perform evaporator weight check and correct weight if necessary? Retest? Return for repair?	___	___

Suggested Wearing Schedule

The purpose of this wearing schedule is to give new team members a chance to practice wearing an apparatus–breathing, moving, and working with it on. Also they will practice performing team checks.

The three sessions of the wearing schedule are designed to be progressively more demanding. This wearing schedule is provided as a guide. You can tailor it to fit the conditions at your mine site and the needs of your team.

Prior to any practice procedures that involve wearing SCBA, the prospective mine rescue team member should be familiar with the construction, assembly, testing, and care of the apparatus being used, and should have met the physical requirements for mine rescue team membership as outlined in 30 CFR, Part 49.

During the initial training sessions, the instructor should monitor the condition of each member closely. Besides checking each team member's general physical condition, the instructor should be on the lookout for signs of potential trouble like these:

1. Rapid, shallow breathing by trainee (indicates inexperience in breathing with an appartus)

2. Excessively heavy breathing (indicates trainee is excited)

3. Facepiece fit

   a. Too loose–indicated by:

      (1) Shifting of facepiece during activity
      (2) Failure to maintain facepiece seal

   b. Too tight–indicated by:

      (1) Red marks on face when facepiece is removed
      (2) Trainee complains of headache

4. Rapid breathing by trainee indicates:

   (1) Lack of confidence in apparatus
   (2) Poor physical condition of trainee
   (3) Improper breathing technique
   or
   (4) Excited condition of trainee

TEAM CHECKS FOR AERORLOX

The team should make an initial check when they put on their apparatus and then stop every 15 to 20 minutes thereafter to make checks.

At each rest stop the team member should be asked if he or she is okay and fit to continue the exercise.

A team check should also include the following:

1. Check of timer.
2. Visual check of facepiece seal.
3. Check that apparatus harness is properly adjusted and has not moved during the exercise.
4. Check that relief valve operates correctly.

During an actual rescue operation the team captain should carry out these checks, and he or she, in turn, should be checked by the co-captain, but during these practice exercises each trainee should be given the opportunity to carry out a check of the other team members. This will ensure that each team member is familiar with the steps and procedures included in a team check.

SESSION 1

It is suggested that the first session be held on the surface. This session should serve primarily to introduce the new trainee to wearing the apparatus. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.
2. Walk at normal speed on level ground (for 10 minutes) to allow trainees to become accustomed to the apparatus.
3. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.
4. Walk over obstructed course, or rough terrain, or climb small hills. (10 minutes)
5. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

6. Each carry a 30 to 50 pound weight (a bag of rock dust, sand, fire extinguisher, etc.) for a distance of approximately 100 yards.

7. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

8. Walk on level ground until 45 minutes to one hour of apparatus wearing has been completed.

SESSION 2

It is suggested that this session be held underground if possible. Have the team perform a physically demanding task while under oxygen so they will begin to understand the limitations imposed upon them by self-contained breathing apparatus. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Select a stopping (or bulkhead) or other point that they can walk to and inspect (traveling should take about 15 to 20 minutes).

3 Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

4. Perform some physical activity such as loading a mine car with rock dust, sand, timber, etc. or building a stopping (or bulkhead) or other physically demanding activity. Have the team perform team checks every 15 to 20 minutes while doing this.

5. Return to surface.

SESSION 3 (Apparatus training in smoke and/or further activities without smoke)

During this session it would be helpful to expose the team to smoke so that they can experience working in smoke and wearing an apparatus under conditions of limited visibility.

If your mining operation is such that a smoke bomb can be used safely underground, this is the most desirable situation. If this is not possible, any confined area–old building, trailer, or a structure made of brattice cloth or plastic–can be used as a smoke room.

Only step 4 of this session is designed for use in smoke. An alternate step 4 is also supplied if smoke cannot be used. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Spend the next 45 minutes to an hour traveling in conditions that approximate the type of conditions they'll encounter in their mine, i.e. climbing ladders, crawling or duck walking in low roof conditions, walking over rough terrain, up and down inclines, etc. Have team stop for team checks every 15 to 20 minutes.

3. Enter smoke area. Before doing this, the team should stop for a team check. Trainees should pay special attention to their facepiece seals to ensure a proper seal—not too loose or too tight.

Procedures that can be stressed and practiced during the team's time in smoke are:

1. Experiencing the disorientation that can occur in heavy smoke.

2. The use of a linkline or lifeline to keep team members together.

3. Following a rail (or a 2 inch x 4 inch for a substitute rail).

4. Feeling and following the rib or side (or wall in a building).

5. Team communications in smoke.

The exercise should be designed so that the team spends no longer than 20 to 30 minutes in smoke. Team should make verbal team checks as necessary and have a complete team check immediately upon leaving the smoke area.

ALTERNATE STEP 4 (If smoke is not used.)

If you are not using smoke, have the team engage in physical activity related to mine rescue, such as carrying a weighted stretcher or stoke's basket, or carrying supplies or objects, such as lumber, timbers, or rolls of brattice. These should be tasks that require more than one person. This activity should take 20-30 minutes. Have team make checks as necessary.

Instructor's Note: This three-session wearing schedule is intended to introduce the trainee to wearing apparatus under a variety of conditions. In annual refresher training the trainees will be performing advanced rescue and recovery procedures while wearing the apparatus.

Appendix

Differences Between Aerorlox Model 013831.05 (1.05) and Model 013831.07 (1.07)

1. Weight. The 1.05 weighs 35 pounds (15.9 kg) when filled with liquid oxygen, falling to 29 pounds (13.2 kg). The 1.07 weighs 34 pounds (15.4 kg) filled, falling to 28 pounds (12.7 kg).

2. Oxygen flow rate. In the 1.05, liquid oxygen vaporizes to gaseous oxygen at a rate of 12 liters per minute (LPM) when filled, going down to 5 LPM at the end of 3 hours. The 1.07 oxygen flow rate goes from 12 LPM down to 4 LPM.

3. The inner chamber of the 1.05 evaporator is filled with an absorbent asbestos. The inner chamber of the 1.07 evaporator is filled with a vermiculite material.

4. Evaporator Flow Check After Wearing. To satisfy this test the flow rate of oxygen for the 1.05 should not be less than 5 LPM. For the 1.07 the flow rate should not be less than 3 LPM.

5. Evaporator Full Flow Check. To perform this test for the 1.05 you will need the 1.05 *Free Evaporation Rate Graph* ("Visual 25"). For the 1.07 you will need the 1.07 *Free Evaporation Rate Graph* ("Visual 26").

General Review

Aerorlox

Directions: Select the correct answer to each of the following questions.

1. The spear valve:
   a. Automatically releases surplus air to the atmosphere.
   b. Warms the inhaled air so the inhalation valve doesn't freeze up.
   c. Removes carbon dioxide from the system.
   d. Prevents air from flowing back into the liquid oxygen evaporator.
   e. Provides an opening for filling the evaporator.

2. The Aerorlox is a liquid oxygen, self-contained breathing apparatus that:
   a. Provides cool, dry air for 3 hours when filled with 3.5 pounds of liquid oxygen.
   b. Provides cool, dry air for 3 hours when filled with 6.5 pounds of liquid oxygen.
   c. Provides cool, dry air when manual valve is correctly operated.
   d. Provides cool, moist air for 2 hours.

3. The Aerorlox timer:
   a. Has a warning alarm that starts to sound when 30 minutes remain of the original 3-hour service time.
   b. Can be read visually or by touch.
   c. Has a warning alarm that starts to sound when 15 minutes remain of the original 3-hour service time.
   d. Is powered by a battery that must be replaced after each wearing.

4. What should you do if liquid oxygen spills on your hand?
   a. Wipe off oxygen with dry towel.
   b. Wash affected area with hot water.
   c. Wash affected area with cold water and cover skin with glycerine.
   d. Ignore it–it's not dangerous.

5. When putting on the apparatus it is important to:
   a. Check the airtightness of the face-to-facepiece seal.
   b. Check for proper functioning of the manometer.
   c. Check for proper functioning of the inhalation and exhalation valves.
   d. a and b.
   e. a and c.

6. Before doing the two Preuse Tests, the Aerorlox unit must be:
   a. Charged with liquid oxygen.
   b. Charged with serviceable Protosorb.
   c. Tested for leaks.
   d. All of the above.

7. When disinfecting the apparatus be sure that:
   - a. No water enters the absorbent canister.
   - b. No water enters the evaporator.
   - c. The Protosorb stays dry.
   - d. The relief valve is completely disassembled.

8. Protosorb must be cared for as follows:
   - a. Shelf life should not exceed one year.
   - b. Can be stored in an apparatus indefinitely.
   - c. Can be used for two wearings before discarding.
   - d. Must be tested before using.

9. The relief valve contains:
   - a. Two black circular-shaped valves.
   - b. Two blue mushroom-shaped valves.
   - c. One ring-shaped valve.
   - d. A single hand-operated valve.

10. One of the limitations of the Aerorlox apparatus is:
    - a. You cannot take the unit off your back and drag it.
    - b. You must preflush the unit to start vaporization of the liquid oxygen.
    - c. You cannot turn the unit off and stop vaporization of the liquid oxygen.
    - d. You must open the main valve properly in order to release the liquid oxygen from the evaporator.

11. When should the timer battery be replaced:
    - a. After each use.
    - b. After 30 days or 30 operational sessions, whichever is sooner.
    - c. After 30 months or 30 operational sessions, whichever is sooner.
    - d. After 6 months.

12. When filling the apparatus with liquid oxygen be sure to:
    - a. Set the timer to 3 hours.
    - b. Filter the liquid oxygen.
    - c. Allow a few minutes before replacing the filler plug.
    - d. Check that scale registers 5½ pounds more than original weight.

13. The Relief Valve Pressure Test is used to determine if:
    - a. The relief valve leaks.
    - b. The relief valve is a one-way valve.
    - c. The relief valve operates between 0.8 and 1.6 inches water gauge.
    - d. All of the above.

14. The Evaporator Full Flow Check:
    a. Must be done once every 30 days.
    b. Should be carried out after 3 hours of apparatus use.
    c. Requires use of the manometer and flow meter.
    d. Requires measuring the oxygen flow rate of a filled apparatus and comparing this to a flow rate graph.

15. When doing the Evaporator Weight Check, you should do all of the following except:
    a. Weigh the evaporator and compare this weight to the weight listed on the serial number plate.
    b. Return the apparatus to the manufacturer if the weight differs more than 4 ounces.
    c. Return the apparatus to the manufacturer if the weight differs by more than one ounce after heating the evaporator in an oven.
    d. Weigh the evaporator with the filler plug in.

General review answers:

1. d
2. b
3. b
4. c
5. e
6. b
7. b
8. a
9. b
10. c
11. c
12. a
13. c
14. d
15. d

Glossary

antidim A solution used to keep moisture and dirt from adhering to the facepiece lens.

baffle A device used to deflect, check, or regulate the flow of air.

condensation A reduction to a denser form, for instance gas to a liquid.

"D" ring Metal "D"-shaped ring.

Dewar flask Container used to carry liquid oxygen from the storage tank to the filling site for filling the Aerorlox apperatus.

evaporate See *vaporize*.

Flordol Disinfectant used to clean the Aerorlox.

flow meter A device used to measure air or oxygen flow.

fractional distillation A process of evaporation and recondensation to separate the various components of a liquid mixture, for example, separate liquid oxygen from liquid air.

glycerine A liquid product which can be used as a lubricant and softener. Glycerine can be used for treating frostbite.

inches water gauge One inch water gauge equals the pressure of 5.2 pounds per square foot.

liquid oxygen Oxygen in the liquid state, which is oxygen at −297° F (−183° C) or lower in temperature.

liter Metric unit of measure which is almost equivalent to one quart: 1 quart = 0.95 liter.

LPM Liters per minute.

manometer A device, calibrated in inches water gauge, used to measure pressure.

Model 1.05, Model 1.07	Two slightly different models of the Aerorlox. The 1.07 is the newer model.
one-way valve	A valve which operates in one direction only–either outward or inward.
positive pressure	Pressure greater than normal atmospheric pressure, creating a "pushing out" force.
Protosorb	The soda lime mixture approved for use in the Aerorlox absorbent canister (8/12 mesh) to absorb carbon dioxide.
PSI	Pounds per square inch.
serial number plate	A metal plate on the side of the outer container of the Aerorlox, that lists the serial number and weight of the outer container stripped of all the removable parts.
shelf life	The length of time that a product can be stored before it begins to deteriorate.
speaking diaphragm	A thin, flexible disc, usually a part of the facepiece, that vibrates (as in a microphone) to allow transmission of one's voice to the outside while wearing the facepiece.
vaporize, evaporate	To change from a liquid to a vapor or gas. In the Aerorlox, liquid oxygen vaporizes or evaporates to gaseous oxygen.

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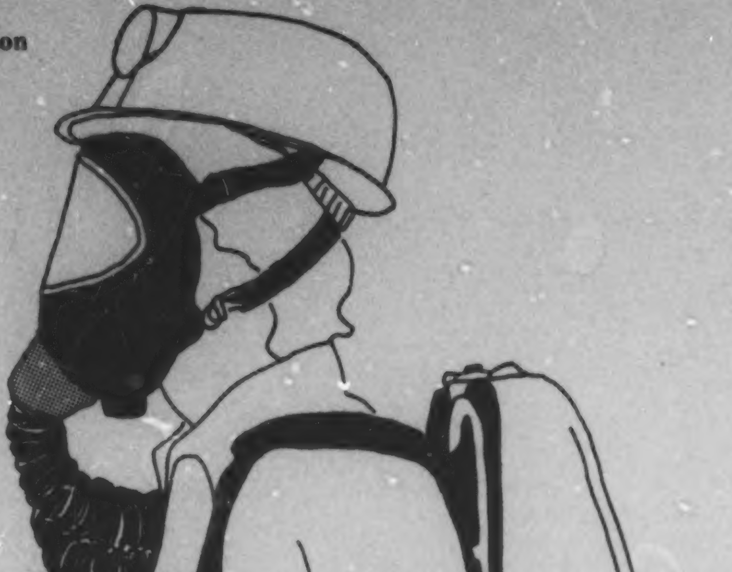
McCaa
Self-Contained Breathing Apparatus

Training Module—Initial Mine Rescue

U.S. Department of Labor
Mine Safety and Health Administration
Education and Training Directorate
November 1981

MSHA 2006



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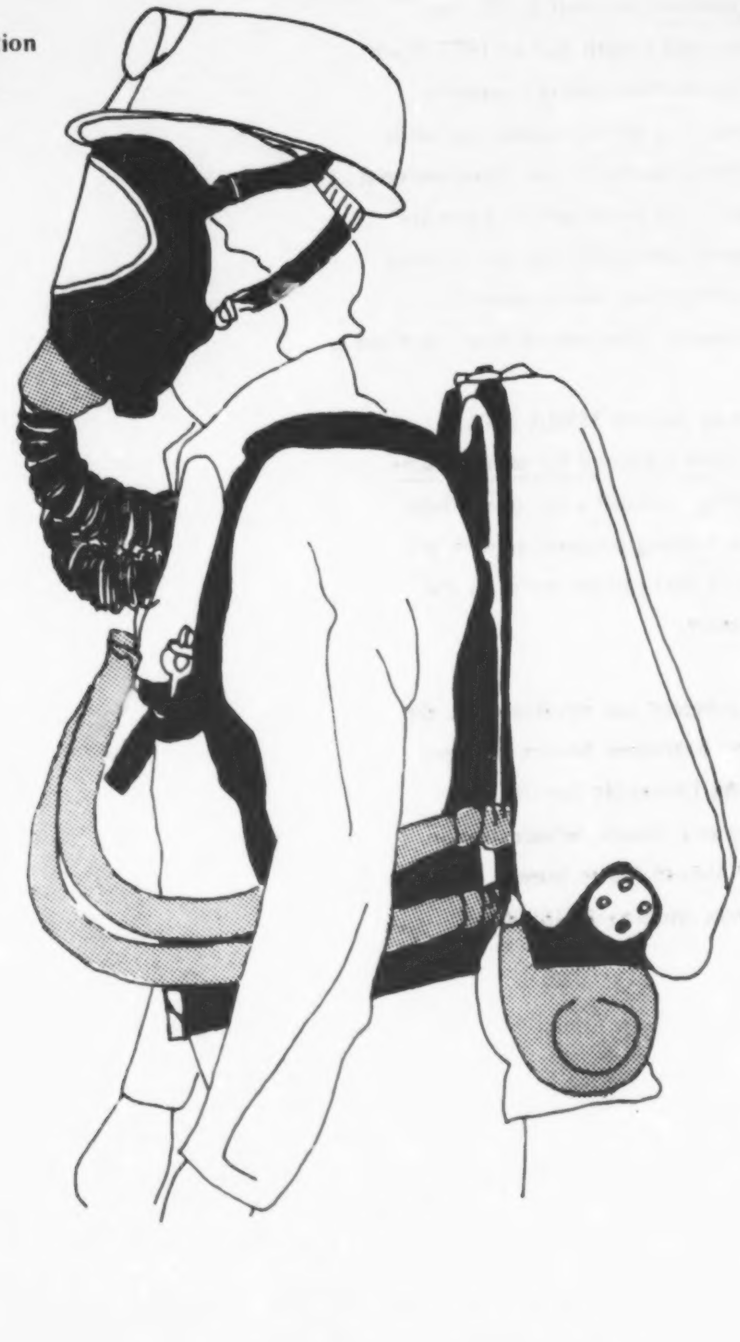

ABOUT THE TRAINING MODULES:

The modules are designed to implement the training of the Nation's mine rescue team members as mandated by Part 49, Subchapter H, Chapter 1, Title 30, Code of Federal Regulations pursuant to the Mine Safety and Health Act of 1977. Each of the modules covers a separate subject in a self-contained unit with suggested handouts and visual material to aid in its presentation. They are designed specifically for the training of underground inexperienced or experienced mine rescue team members.

Training module MSHA 2001, Instructor's Manual for Mine Rescue Training, contains a list of modules in the training program as well as a glossary that can be useful to the instructor.

This program was developed by the Mining Extension Service of West Virginia University for the Mine Safety and Health Administration under United States Bureau of Mines Contract Number JO308002.

McCaa Self-Contained Breathing Apparatus

Training Module–Initial Mine Rescue

U.S. Department of Labor
Raymond J. Donovan, Secretary

Mine Safety and Health Administration
November 1981

MSHA 2006

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Course Objectives

Main objective

The mine rescue team member will be able to properly use and maintain the McCaa self-contained breathing apparatus.

Supportive objectives

The team members will:

1. **Describe the McCaa 2-hour self-contained breathing apparatus.**

2. **List the major parts of the McCaa and describe their function:**

    a. **Protective cover**

    b. **Wearing harness**

    c. **Oxygen cylinder**

    d. **Cylinder valve assembly**

        (1) **Main cylinder valve**
        (2) **Bypass valve**

    e. **Reducing valve**

    f. **Pressure gauge and gauge valve**

    g. **Oxygen supply line**

    h. **Admission valve**

    i. **Safety valve**

    j. **Breathing bag and cooler**

    k. **Regenerator**

    l. **Rigid breathing hoses**

    m. **Flexible breathing hoses**

    n. **Facepiece and valve assembly or mouthpiece and valve assembly**

        (1) **Inhalation and exhalation valves**
        (2) **Pressure relief valve**

3. Describe the breathing circuit of the McCaa apparatus.

4. Put on and take off the McCaa apparatus correctly and check it for proper functioning.

5. Define the limitations of the apparatus when it is worn and practice wearing the apparatus.

6. Perform required and recommended testing and maintenance for the McCaa apparatus.

Course Materials

Required:

Handouts and visuals from the back of this module

Pencil and paper for each team member

McCaa breathing apparatus

Source of oxygen and cascade system or high pressure oxygen pump

Cardoxide

Disinfectant and cleaning solutions

Low-pressure test gauge for testing apparatus

Antifog solution and wiping tissue for facepiece

Suggested:

Overhead projector

Equipment for making copies and/or transparencies

Chalkboard

Optional Resources:

The manufacturer's information which comes packed with the apparatus

Course Outline

- I. The McCaa apparatus
  - A. Description
  - B. How it works

- II. Parts of the McCaa
  - A. Protective cover
  - B. Wearing harness
  - C. Oxygen cylinder
  - D. Cylinder valve assembly
    - 1. Main valve
    - 2. Bypass valve
    - 3. Safety cap
    - 4. Threaded connection
    - 5. Metal tube
  - E. Reducing valve assembly
  - F. Pressure gauge and gauge valve
  - G. Oxygen supply line
  - H. Admission valve
  - I. Safety valve
  - J. Breathing bag and cooler
  - K. Regenerator
  - L. Breathing hoses
    - 1. Rigid
    - 2. Flexible
  - M. Facepiece
    - 1. Ultravue facepiece
      - a. Valve housing
      - b. Inhalation and exhalation valves
      - c. Speaking diaphragm
      - d. Pressure relief valve
    - 2. All-Vision facepiece
      - a. Valve housing
      - b. Inhalation and exhalation valves

        - c. Pressure relief valve
        - d. Speaking diaphragm
    - N. Mouthpiece (Appendix)

- III. The breathing circuit
    - A. Airflow design

- IV. Putting on the apparatus
    - A. Put on apparatus and facepiece
    - B. Check facepiece seal and one-way valves
    - C. Purge the apparatus and flush with oxygen
    - D. Check bypass valve
    - E. Check pressure gauge
    - F. Putting on mouthpiece (Appendix)

- V. Taking off the apparatus
    - A. Remove facepiece
    - B. Close cylinder valve
    - C. Take off unit
    - D. Removing mouthpiece (Appendix)

- VI. Wearing the apparatus
    - A. Limitations
        - 1. Time limit, work rate, and breathing rate
        - 2. Size and weight of apparatus
        - 3. Mouthpiece limitations (Appendix)
    - B. Checks to make while wearing the apparatus
        - 1. Blowing off
        - 2. Checking pressure gauge
        - 3. Using bypass valve
        - 4. Checking admission valve
    - C. Wearing schedule

VII. Bench duties
  A. Cleaning and disinfecting the apparatus
  B. Storing the apparatus
  C. Oxygen cylinders
    1. Description
    2. Handling and storing
    3. Filling with oxygen
  D. Cardoxide
    1. Description
    2. Filling the regenerator
  E. Testing the apparatus
    1. Recordkeeping
      a. Testing records
      b. Maintenance records
      c. Tagging
    2. Testing procedure
      a. Visual inspection
      b. Cylinder valve assembly leak test
      c. Removing moisture from cylinder
      d. Filling the regenerator
      e. Inserting the oxygen cylinder
      f. Connecting low-pressure test gauge
      g. Reducing valve pressure test
      h. Reducing valve and pressure gauge leak test
      i. Oxygen flow test of reducing valve
      j. Safety valve and whistle test
      k. Removing test gauge
      l. Facepiece and flexible hoses test
        (1) Regular test
        (2) Valve testing in water
      m. Mouthpiece and flexible hoses test (Appendix)
      n. Assembling the apparatus
      o. Assembled apparatus leak test
        (1) Leak testing high- and medium-pressure side
        (2) Checking admission valve
        (3) Checking safety valve
        (4) Leak testing low-pressure side

Instructor Notes

Suggested Lecture

Note: The McCaa is approved to be worn with either a facepiece or a mouthpiece. This module is written for an apparatus with a facepiece. In most cases, if you use a mouthpiece, you can simply substitute the word mouthpiece for facepiece during the lecture. However, in some cases, the mouthpiece lecture will be different from the facepiece lecture. In these cases, the mouthpiece lecture will be included as an *Appendix* at the back of the module. A *Mouthpiece note* in the instructor notes will refer you to the *Appendix* when necessary.

Note: Throughout this module, the *Visual* notes will recommend that you point out parts, etc., on an actual McCaa apparatus. The *Visual* notes will also refer you to various visuals in the back of the module. You should, if possible, make overhead transparencies of the visuals, or sketch them on a chalkboard, or make copies of them to distribute as handouts to the team members (depending on the type of visual).

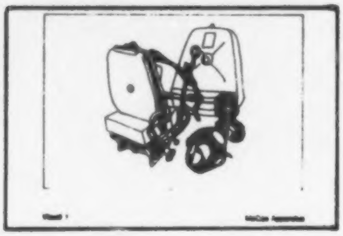
It is recommended that you use both the apparatus *and* the visuals to aid in an overall understanding of the apparatus. However, the use of one or the other will suffice.

THE McCAA APPARATUS

Objective 1: The team members will describe the McCaa 2-hour self-contained breathing apparatus.

Visual: Display a McCaa apparatus so that the team can get acquainted with it as you begin the lecture, and/or refer to "Visual 1" for a picture of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The McCaa is a 2-hour, self-contained, closed-circuit breathing apparatus that uses compressed oxygen as its source of oxygen.

This apparatus, manufactured by the Mine Safety Appliances Company (MSA), was first approved for mine rescue work in 1925 under Bureau of Mines' Schedule 13. At that time the apparatus was used with a mouthpiece. In 1959 the apparatus was approved by the Bureau of Mines for use with a facepiece.

More recently, new NIOSH and MSHA standards for approval have been set forth in Title 30, Code of Federal Regulations (30 CFR), Section 11. This replaces the Schedule 13 standards.

The McCaa apparatus has not been approved under these new standards. However, it has been "grandfathered" under 30 CFR so that it is still acceptable for mine rescue work.

Reference: The reference for the following law is 30 *CFR*, section 11.2(b).

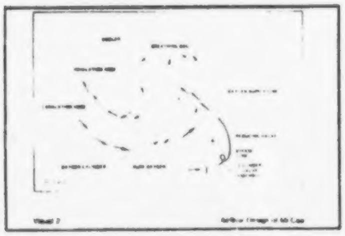
Regarding the grandfather clause, 30 CFR states that a self-contained breathing apparatus approved under the former Bureau of Mines approval program (the McCaa) "shall continue to be accepted for use in hazardous atmospheres" provided that it is maintained in an approved condition.

This is what really concerns you as team members. It is very important that you keep the McCaa in good condition, testing it regularly and replacing worn or defective parts as needed. The McCaa is no longer being manufactured but replacement parts are available for it.

How It Works

Visual: Use an apparatus as an aid in describing the following air flow through the apparatus, and/or refer to "Visual 2" for a cut-away view of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Note: A more detailed explanation of how the McCaa works is given later on in the "Breathing Circuit" section of the module. Do not go into detail at this point. Keep it general.

Basically, the McCaa works like this: When you inhale, oxygen-enriched air is drawn out of the breathing bag and into your lungs by way of the inhalation hose.

When you breathe out, the exhaled air passes into the regenerator where the carbon dioxide is removed. Then the air (minus the carbon dioxide) moves along to the breathing bag where it mixes with fresh oxygen from the oxygen cylinder and is stored until you inhale it again.

As you can see, the McCaa is a self-contained, closed-circuit system. You rebreathe the same air, rid of carbon dioxide and enriched with oxygen.

Objective 2: The team members will list the major parts of the McCaa and describe their function:

a. Protective cover
b. Wearing harness
c. Oxygen cylinder
d. Cylinder valve assembly
    (1) Main cylinder valve
    (2) Bypass valve
e. Reducing valve
f. Pressure gauge and gauge valve
g. Oxygen supply line
h. Admission valve
i. Safety valve
j. Breathing bag and cooler
k. Regenerator
l. Rigid breathing hoses
m. Flexible breathing hoses

n. Facepiece and valve assembly or
   mouthpiece and valve assembly
   1. Inhalation and exhalation valves
   2. Pressure relief valve

Visual: Point out the following parts on an apparatus, and/or refer again to "Visual 2" for a cut-away view of the apparatus as you discuss the following section.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The McCaa apparatus has five main parts:

1. An oxygen cylinder;

2. A pressure reducing valve;

3. A breathing bag and cooler;

4. A regenerator; and

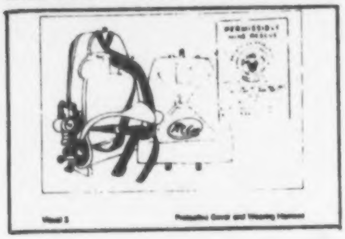
5. Breathing hoses and a facepiece or mouthpiece.

Other parts of the McCaa include: the protective cover and wearing harness; a pressure gauge; and various valves which control the flow of oxygen.

Protective Cover

Visual: Point out the protective cover on an apparatus, and/or refer again to "Visual 3" for a picture of the cover.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The internal parts of the McCaa are protected from damage and dirt by the protective cover which fits on the apparatus. This cover, made of a heavy aluminum alloy hinges at the bottom of the apparatus just above the oxygen cylinder and latches at the top of the apparatus.

The approval label issued by the Bureau of Mines under Schedule 13 is located at the top of the cover.

To remove the cover from the apparatus, simply:

Demonstration: Demonstrate, using an apparatus, how to remove and replace the protective cover as you describe the following procedures. Either demonstrate it yourself or have a team member do it as you describe the procedures.

1. Undo the latch at the top of the apparatus; and
2. Lift the cover away from the apparatus so it disengages from the bottom of the apparatus.

Now, to replace the cover:

1. Hinge the tabs at the bottom of the cover onto the bar near the bottom of the apparatus.
2. Bring the cover up to the closed position; and
3. Hook the latch at the top of the apparatus.

Wearing Harness

Visual: Point out the wearing harness on an apparatus, and/or refer once again to "Visual 3" for a drawing of the harness.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

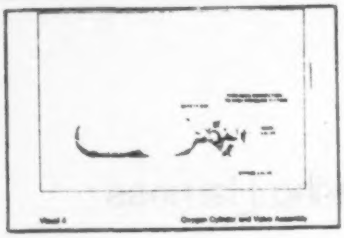
Demonstration: Demonstrate how to fasten and adjust the harness straps as you discuss it below. (The team members will learn how to put on the apparatus later on in the lecture.)

The wearing harness, when properly adjusted, allows you to comfortably carry the apparatus on your back. The harness has padded shoulder straps, a chest strap, and a waist belt, all with buckles for adjusting the fit. The harness should be adjusted for a comfortable fit when you wear the apparatus.

Oxygen Cylinder

Visual: Point out, on an apparatus, the oxygen cylinder, and/or refer to "Visual 4" for a drawing of the cylinder.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The oxygen cylinder fits horizontally at the bottom of the apparatus. The cylinder connects to the apparatus by a threaded connection on the cylinder's valve assembly, and is held in place by an adjustable metal strap at the center of the cylinder's carrying frame.

The cylinder is designed to contain oxygen under very high pressure. It is constructed of steel and must be tested every 5 years to see that it remains in good condition. We will be discussing more about this testing procedure later on when we go over the care and maintenance of the McCaa.

Note: The testing procedure described above is "hydrostatic testing" and will be explained in the "Oxygen Cylinder" section of "Bench Duties."

On the McCaa, the cylinder is filled with oxygen to 150 atmospheres, or about 2200 pounds per square inch (PSI) the amount required for the 2 hours of wearing time for which the apparatus is approved.

Note: One (1) atmosphere equals approximately 14.7 PSI.

To get the cylinder out of the apparatus:

Demonstration: Demonstrate, using an apparatus, how to remove and replace the oxygen cylinder as you discuss the following procedures. Either demonstrate it yourself or have a team member do it as you describe the procedures.

1. **Position the apparatus so the breathing bag faces you;**
2. **Disconnect the bypass tube from the cylinder;**
3. **Loosen the metal strap that holds the cylinder in place by unscrewing the metal nut at the center of the cylinder's carrying frame;**
4. **Unscrew the cylinder and valve assembly from the apparatus by using a wrench to turn the large metal nut that the threaded connection fits into;**
5. **Raise the reducing valve to clear the face of the cylinder outlet and then rotate the cylinder 90 degrees (¼ turn) so that the bypass knob points toward you;**

Note: Since you have not yet mentioned what or where the cylinder valve assembly is, make sure that you specifically point out where the valve assembly connects to the apparatus. (You can refer back to "Visual 2" for a drawing of the apparatus.)

6. When the valve assembly is free of the apparatus connection, slide the cylinder to the left, out of its carrying frame.

Now, to replace the cylinder in the apparatus, simply:

1. Slide the cylinder (with the bypass knob pointing toward you) back into its frame, sliding the bottom of the cylinder in from the left side of the frame;
2. Raise the reducing valve to clear the face of the cylinder outlet and rotate the cylinder back 90 degrees;
3. Connect the cylinder valve assembly to the apparatus by screwing the metal nut all the way onto the valve assembly's threaded connection;
4. Connect the bypass tube to the cylinder;
5. And finally, snug up the metal strap that holds the cylinder in place by tightening the metal nut at the center of the cylinder's carrying frame.

Cylinder Valve Assembly

Visual: Point out the parts of the cylinder valve assembly as you discuss them in the following section, and/or refer once again to "Visual 4" for a picture of the valve assembly.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Located at the neck of the oxygen cylinder is the cylinder valve assembly. This valve assembly contains two valves–the main cylinder valve and the bypass valve. Both of these control the passage of oxygen to the apparatus, though in different ways.

The valve assembly also is made up of three other parts–the safety cap, a threaded connection, and a metal tube. We will discuss these parts later on.

Main Cylinder Valve

The main cylinder valve, when open, allows oxygen to enter the apparatus from the cylinder. This valve has a knob on it which can be hand-tightened so that you can easily open and close the valve.

Demonstration: Demonstrate how the valve is opened and locked in the open position as you discuss the following procedure. Either demonstrate it yourself or have a team member do it.

Note: The following procedure is described assuming that the cylinder is in place in the apparatus.

To open the valve, turn the knob counterclockwise until it stops. Then it is important to lock it in the open position by taking the safety chain that hangs from above the cylinder and attaching its hook to the metal ring on the valve knob. This chain is provided as a safety feature to prevent the knob from accidentally closing, so be sure to use it.

Bypass Valve

The McCaa's bypass valve is located below the main valve on the cylinder valve assembly. This bypass valve allows oxygen to enter the apparatus by "bypassing" the parts of the apparatus which normally control the oxygen's flow (should these parts fail to work properly and you're not being supplied with enough oxygen).

By opening the bypass valve, the oxygen goes directly from the cylinder to the cooler via the bypass line which is the curved metal tube running from the valve assembly upward to the cooler.

Visual: You may wish to refer back to "Visual 3" for a drawing of where the bypass line is located.

This shortcut route from the cylinder to the cooler allows the oxygen to bypass the parts which are normally inbetween; namely the pressure reducing valve assembly which you will be learning more about later on in the class.

You should use this bypass valve only if you are not getting enough oxygen. Continued opening of the bypass valve will use up your oxygen supply at a faster-than-normal rate.

When you do use the bypass valve, open the valve momentarily by turning the knob counterclockwise. Then close it immediately. You should continue to manually open and close the valve as needed so as to conserve oxygen as much as possible.

Note: Prolonged use of the bypass valve may overpressurize the apparatus. Should overpressurization occur, the wearer will

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not be able to exhale until the pressure in the unit is reduced by using the pressure relief valve on the facepiece. The pressure relief valve will be discussed in the *Facepiece* section of this module.

Safety Cap

Note: *Never* disassemble the safety cap.

At the center of the cylinder valve assembly is the safety cap. This cap is designed as a safety feature to allow oxygen to escape from within the cylinder if the pressure or temperature within the cylinder increases to a dangerous level due to heat or fire.

Note: The cap contains Rose's metal (an alloy of bismuth, tin, lead) which will melt at 94° C. It also has a frangible copper disk that will rupture at the pressure stamped on the cap.

If you look closely at the safety cap, you will see that there are small holes drilled around the perimeter of the cap. These holes are the holes through which the oxygen escapes when the cylinder becomes overpressurized. This keeps the cylinder from rupturing under the high pressure.

Threaded Connection

The threaded connection located at the top of the cylinder valve assembly joins the assembly to the apparatus.

The threaded connection screws into the high-pressure fitting located at the bottom of the reducing valve assembly.

Note: The right side of the apparatus, at this point and from here on, refers to the side which would be on the wearer's right if one were wearing the apparatus.

Metal Tube

The other major part of the valve assembly is an inner metal tube. The tube is located within the valve assembly and extends about 2 inches into the oxygen cylinder. This tube allows oxygen to flow from the center of the cylinder into the apparatus. Because this tube is in the center of the cylinder, it prevents foreign material (such as rust, sediment, or moisture) from entering the cylinder valve assembly and the apparatus.

Reducing Valve Assembly

Visual: Point out, on an apparatus, where the reducing valve assembly is located, and/or refer to "Visual 5" for a drawing of the reducing valve.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

When oxygen enters the apparatus from the main cylinder valve, it first goes through the reducing valve assembly, where the high-pressure oxygen is reduced to a lower, more breathable pressure.

The major parts which make up the reducing valve assembly are:

Visual: Refer to "Visual 5" (if you haven't already) for a cutaway view of the reducing valve assembly so that you can point out the internal parts. The parts are labeled for your reference.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. A high-pressure fitting;
2. A nozzle with a metal spring at its end;
3. The valve housing which contains a casenite seat and a lever arm joint with a metal rod attached; and
4. The bellows.

All these parts work together to reduce the pressure of the oxygen as it enters the apparatus from the cylinder.

This is how the reducing valve works:

Visual: Using "Visual 5" for a cutaway drawing of the reducing valve, trace the flow of oxygen through the valve as you describe it below.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

When the main valve of the oxygen cylinder is open, high-pressure oxygen enters the high-pressure fitting, passes through the nozzle, and enters the valve housing where the pressure is reduced through a mechanical process.

As the oxygen fills the valve housing it extends or lengthens the bellows, which in turn extends the metal rod. As the metal rod extends, it forces the casenite seat to close tightly on the end of the nozzle, thereby shutting off the flow of oxygen until the bellows recedes and the casenite seat opens again.

When the casenite seat closes, the oxygen is confined in the valve housing until it is admitted to the rest of the apparatus through the admission valve, which we will be talking about shortly. While in the valve housing, the oxygen is at about 3 to 4½ PSI.

Pressure Gauge and Gauge Valve

Visual: Point out, on an apparatus, where the pressure gauge and gauge valve are located, and/or refer to "Visual 6" for a drawing of them as you discuss the following section.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

When oxygen enters the high-pressure fitting, it not only goes into the reducing valve but also through the gauge valve and up to the pressure gauge where the oxygen pressure in the cylinder is indicated. The gauge is graduated in atmospheres.

The gauge valve controls the admission of high-pressure oxygen to the pressure gauge. This valve has a knob on it which can be hand-tightened so that you can easily open and close the valve.

When the main cylinder valve is open (along with the gauge valve), high-pressure oxygen goes through the gauge valve and up the gauge line to the pressure gauge where the cylinder's oxygen pressure is indicated.

When wearing the apparatus, the gauge is on the end of a line that comes up from the high-pressure fitting and sits in a leather sleeve on the right shoulder strap of the harness. To read the gauge you simply pull it out of the sleeve.

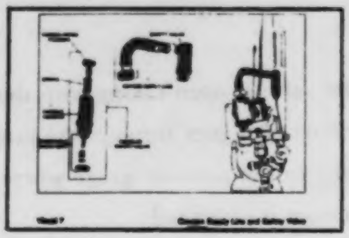
Then when you're finished, place the gauge back into the sleeve by tugging down on the gauge line. This sleeve will hold the gauge and protect it from external damage, so you should keep the gauge in the sleeve when you're not using it.

If the pressure gauge or gauge line develops a leak while you are wearing the apparatus, you should close the gauge valve so as to keep your oxygen supply from leaking to the outside. Then return to fresh air as soon as possible.

Oxygen Supply Line

Visual: Point out, on an apparatus, where the oxygen supply line is located, and/or refer to "Visual 7" for a drawing of the oxygen supply line.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



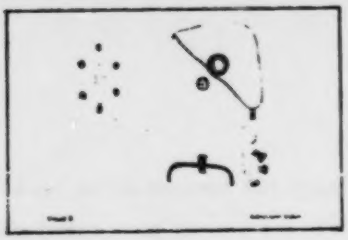
When the oxygen leaves the reducing valve assembly on its way to the breathing bag, it travels through the oxygen supply line. The rubber hose that you see coming off the top of the reducing valve assembly and connecting to the cooler is the first part of this line.

Another metal tube then continues on the inside of the cooler to carry the oxygen up to the center of the breathing bag where it is admitted to the bag.

Admission Valve

Visual: Using an apparatus, lift up the breathing bag to show the team what the admission valve looks like as you discuss the following section, and/or refer to "Visual 8" for drawings of the valve.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Note: In order to lift the bag away from the cooler, you first have to unscrew the bag from the back of the cooler. Unscrew all six screws and then pull the bag away from the admission valve area of the cooler.

The admission valve is located at the center of the breathing bag and cooler. It functions to "admit" oxygen into the breathing bag from the reducing valve.

The admission valve itself consists of a housing with a shaft that extends into the breathing bag. If you remove the screws attaching the breathing bag to the center of the cooler, and lift up on the bag, you can see how this shaft fits into the breathing bag. At the tip of the shaft you will see a small stem protruding. This stem moves in and out, opening and closing the admission valve.

You will also see that there are small holes at the base of the shaft. These are the holes through which oxygen flows as it enters the breathing bag.

Note: Be aware that there are two types of admission valves that have been used in the McCaa. The type used in apparatus made before 1956 has six holes at the shaft base and is used when wearing the mouthpiece. After 1956, the valves were manufactured with twelve holes to be used when wearing the facepiece. The only difference between the two valves is that the twelve-hole valve permits a higher flow rate of oxygen than the six-hole valve.

Now, if you look through the opening at the back of the breathing bag, you will see a metal plate called the bumper plate. This functions to "bump" against the stem of the admission valve, causing the valve to open.

Here is how the admission valve works.

Demonstration: As you describe the following procedure, demonstrate how the bumper plate and stem move in and out to open and close the admission valve.

When you inhale all the air from the bag and the bag is drawn inward toward the cooler, the bumper plate strikes the stem of the admission valve, causing the valve to open. As soon as the valve opens, oxygen flows into the bag from the reducing valve and oxygen supply line.

As the bag inflates again, the bumper plate raises away from the stem of the admission valve and the valve closes.

Now, here is how the admission valve works in conjunction with the pressure reducing valve.

Visual: Using "Visual 5" for a cut-away drawing of the reducing valve, trace the flow of oxygen through the valve as you describe it below.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

When the admission valve opens and oxygen flows in from the pressure reducer assembly, the pressure in the assembly reduces, causing the bellows to contract. This, in turn, causes the metal rod to contract, which moves the casenite seat away from the nozzle, allowing oxygen to flow through the reducing valve. This oxygen continues to flow through the reducing valve as long as the admission valve is open.

When the breathing bag inflates again, the admission valve closes and the oxygen backs up in the reducing valve. As the pressure builds up in the valve, the bellows expands causing the metal rod to extend and the casenite seat to close, thereby shutting off the flow of oxygen to the reducing valve.

When the breathing bag is again fully deflated, the admission valve will open, and the mechanical process in the reducing valve will repeat. This "cycle" is carried on automatically while you wear the apparatus.

Safety Valve

Visual: Point out, on an apparatus, where the safety valve is located, and/or refer again to "Visual 7" for a drawing of the safety valve.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The McCaa has a safety valve to vent excess pressure from the apparatus and to serve as a warning whistle device. It screws into and extends below the lower right portion of the cooler.

The safety valve is designed to vent excess pressure from the apparatus if the reducing valve fails to reduce the pressure to the proper amount.

The air is vented through an opening in the valve housing which is actually a whistle. So while the air is escaping, a whistle sounds to warn you of the malfunction.

The safety valve is made up of three main parts:

Visual: Take the safety valve apart and point out its following parts, and/or refer again to "Visual 7" for a drawing of the parts. The parts are labeled for your reference.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

1. A whistle housing;

2. A rubber-tipped plunger;

3. A spring; and

4. A valve seat.

Here is how the safety valve works. Normally the opening from the oxygen supply line to the safety valve remains closed because the rubber tip of the plunger blocks the entrance. However, because the plunger is "spring loaded," it can move away from the opening if there is enough pressure to push it. And enough pressure would be present if the reducing valve failed to sufficiently reduce the oxygen pressure.

Note: The oxygen is supposed to flow out of the reducing valve at the rate of at least ½ PSI.

If the pressure exceeds 7 to 9 PSI, the plunger will be forced downward, opening the valve. And as the excess oxygen pressure flows through the valve and out the whistle, you will hear the warning and know that your reducing valve is malfunctioning.

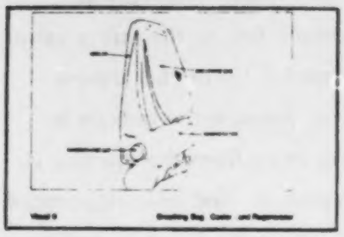
If your whistle sounds while you're wearing the apparatus, you should close the main cylinder valve and obtain oxygen by manually opening and closing the bypass valve. You should then return to fresh air immediately.

Note: When the bypass valve is in use, the pressure release feature of the whistle is inoperative. This is because the admission valve is closed and pressure in the cooler and breathing bag cannot get to the safety whistle.

Breathing Bag and Cooler

Visual: Point out, on an apparatus, where the breathing bag and cooler are located, and/or refer to "Visual 9" for a drawing of them.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The breathing bag and cooler serve as an air reservoir which you breathe from and into when wearing the apparatus.

The breathing bag, which attaches to the cooler at the top and center, is made of fabric-covered sheet rubber and has the capacity to hold about 8 quarts (about 7½ liters) of air.

The cooler is constructed of sheet metal which helps to cool the exhaled air coming out of the regenerator. The cooler is basically one large compartment with a baffle dividing part of it so that the exhaled air coming out of the regenerator will have to make a complete circuit of the cooler, thereby cooling the air before it enters the inhalation hose.

Demonstration: As you discuss the following section, lift up the breathing bag to show the team the opening which surrounds the admission valve.

You will notice on the cooler, if you lift up the breathing bag, that there is an open area surrounding the admission valve. This opening in the cooler, along with the opening on the back of the breathing bag, allows for the free exchange of air between the two sections.

Regenerator

Visual: Point out, on an apparatus, where the regenerator is located, and/or refer again to "Visual 9" for a drawing of the regenerator.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The rectangular metal box that you see above the oxygen cylinder is the regenerator. Remember, the function of the regenerator is to remove carbon dioxide from your exhaled air.

The McCaa's regenerator is a refillable-type container that holds about 4 pounds (about 1.7 kilograms) of Cardoxide, a carbon dioxide-absorbing chemical that resembles vermiculite.

Note: Cardoxide is the only chemical approved by the Bureau of Mines for use with the McCaa.

To fill the regenerator you must remove the regenerator cap and pour in 4 pounds (1.7 kilograms) of Cardoxide. You will be learning the proper procedure for filling the regenerator later on in the lecture.

__Note__: The proper procedure for filling the regenerator is covered in the "Bench Duties" part of the lecture.

The regenerator is designed so that exhaled air enters the regenerator at the left side and exits at the right side, thereby passing all the way through the Cardoxide for the most efficient removal of the carbon dioxide.

Breathing Hoses

There are two sets of breathing hoses used with the McCaa: the rigid hoses and the flexible hoses.

Rigid Breathing Hoses

__Visual__: Point out what the rigid hoses look like, and/or refer to "Visual 10" for a drawing of the hoses.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The rigid breathing hoses attach at one end to the apparatus, and at the other end to the flexible breathing hoses that go to the facepiece. You will notice that the hoses are not the same length. Because the hoses fit onto the apparatus one above the other, it is necessary for one hose to be longer than the other. The longer hose is the exhalation hose and the shorter hose is the inhalation hose.

The metal piece that joins these two hoses together at one end also connects the hoses to the chest strap of the wearing harness. The chain attached to the metal piece fastens onto the wearing harness at the metal "D" ring on the left shoulder strap.

Visual: Point out where, on an apparatus, the rigid hoses connect, and/or refer to "Visual 11" for a drawing of the hose connections.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

If you look at the hose connections on the back of the apparatus, you will see that the upper connection on the cooler is labeled "Inhalation" and the lower connection on the regenerator is labeled "Exhalation."

The longest hose, the exhalation hose, attaches to the exhalation connection on the regenerator. The shorter hose attaches to the inhalation connection on the cooler. When the hoses are attached, they should be firmly hand-tightened to prevent leakage.

There should be a screen in place in the regenerator's exhalation connection to keep the Cardoxide from spilling out into the breathing hose. This screen is held in place by a round retaining clip and can be removed for cleaning or replacement.

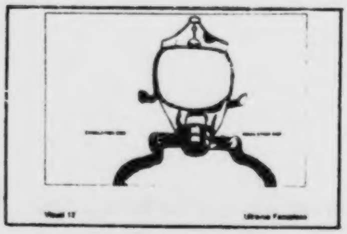
Flexible Breathing Hoses

Visual: Point out what the flexible breathing hoses look like, and/or refer to one of the following visuals for a drawing of the hoses. Choose the visual of the facepiece that the team uses:

Ultravue facepiece–"Visual 12"

All-Vision facepiece–"Visual 14."

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Visual 14
All-Vision Facepiece

The flexible breathing hoses are made of corrugated rubber. They generally remain attached to the facepiece with metal screw clamps. The other end of the hoses connect to the rigid breathing hoses–exhalation hoses together and inhalation hoses together.

It is important to remember that the flexible inhalation hose comes off the left side of the facepiece (when wearing it) and the flexible exhalation hose comes off the right side of the facepiece.

When you are connecting the flexible hoses to the rigid hoses, the flexible inhalation hose (on the wearer's left) connects to the shorter rigid inhalation hose. The flexible exhalation hose (on the wearer's right) connects to the longer rigid exhalation hose.

These hoses connect to each other by threaded couplings. When you connect these two sets of hoses, be sure that you firmly hand-tighten the connections. Rubber gaskets are used in the couplings to ensure an airtight seal.

Facepiece

The McCaa apparatus is approved to be worn with one of two facepieces–the Ultravue facepiece or the All-Vision facepiece–or with a mouthpiece, as originally approved.

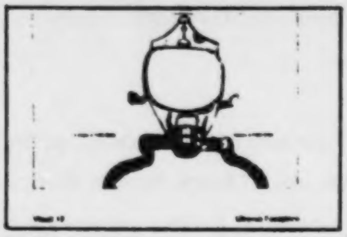
Mouthpiece note: Refer to the *Appendix* for the lecture, "Mouthpiece Description."

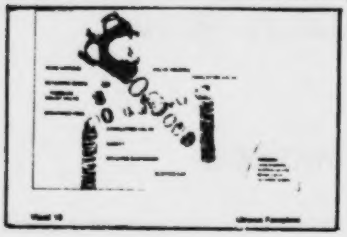
Ultravue Facepiece

Note: If your team uses the All-Vision facepiece, skip over this section on the Ultravue, and go on to the All-Vision facepiece section.

Visual: Display the Ultravue facepiece and point out the following parts, and/or refer to both "Visual 12" and "Visual 13" for drawings of the facepiece.

Use these visuals as overhead transparencies, chalkboard sketches, or handouts.





The Ultravue facepiece is made of molded rubber and has a single lens across the front of it.

The facepiece is held in place by the head harness which has five adjustable rubber straps. By pulling on the ends of these straps once the facepiece is positioned over your face, you can snug up the facepiece and get a good face-to-facepiece seal around the edges.

On the inside of the facepiece just below the lens are two air ducts. The oxygen enriched air passes through these ducts when it enters the facepiece, and flows across the inner surface of the lens to help prevent fogging.

The Ultravue also has other parts which we will discuss in detail: the valve housing which contains the inhalation and exhalation valves and speaking diaphragm; and the pressure relief valve.

Valve Housing

At the bottom of the facepiece is a hard plastic unit known as the valve housing. This valve housing connects the facepiece to the breathing hoses. It also houses the inhalation and exhalation valves and the speaking diaphragm.

Inhalation and Exhalation Valves

The inhalation and exhalation valves are designed to help keep air flowing in a one-way direction. The inhalation valve on the left side of the facepiece (when wearing) allows air to flow into the facepiece. The exhalation valve, on the right, permits air to flow out of the facepiece.

Demonstration: Remove the breathing hoses from the facepiece so as to expose the inhalation and exhalation valves. Then put on the facepiece and breathe, demonstrating how the valves open separately (as you inhale and exhale) to keep the air flowing in one direction. Be sure to reattach the hoses when finished.

Keep in mind that in a closed-circuit breathing apparatus it is very important to keep the air flowing in one direction only. If it didn't, you'd risk breathing in exhaled air filled with carbon dioxide, or else fresh oxygen might not reach you.

If you take these valves out of the valve housing and compare them, you will notice that the ridges are closer together on the inhalation valve on the left side of the facepiece (when wearing). There are grooves at each end of the valve housing to match the ridges on each of the valves. This is so that you don't put the valves back into the wrong housing.

Speaking Diaphragm

The Ultravue's speaking diaphragm is located behind the round slotted cap at the center of the valve housing. The speaking diaphragm, which is actually a thin, flexible disc in a metal housing, vibrates in order to transmit your voice to the outside when you speak with the facepiece on.

Demonstration: Unscrew the slotted cap (using the special wrench) from the valve housing and take out the speaking diaphragm as you discuss the following section. Then replace the speaking diaphragm in the valve housing.

You can easily remove the speaking diaphragm by unscrewing the slotted cap from the valve housing and taking out the diaphragm. A wrench should be provided with the facepiece to aid in unscrewing the slotted cap.

A removable rubber gasket is located behind the diaphragm. If you ever take out the speaking diaphragm, always make sure the rubber gasket is in place before you put the diaphragm back into the valve housing.

When reinstalling the speaking diaphragm, be careful not to install it backwards. If it's installed backwards it will not seal. The side with the bumps must be against the slotted cap so it exerts pressure against the rubber gasket and has a proper seal.

Pressure Relief Valve

The pressure relief valve is located at the very bottom of the facepiece in its own housing. The relief valve is a hand-operated one-way valve that you open by pushing in on the plunger which protrudes from the housing.

When you push in on the plunger and open the valve, air can be vented to the outside of the facepiece by blowing out through the valve. And because this is a one-way valve, no air will enter the facepiece through the valve. When you release the plunger and the valve closes, air cannot be vented to the outside.

If you have ever watched teams wearing McCaas, you may have noticed that they stop every 15 to 20 minutes to "blow off" which involves forcefully exhaling through the relief valve in order to purge the unit of nitrogen. The reason for this is because the McCaa does not automatically vent excess rebreathed air to the outside. So it is necessary for the wearer to "blow off" the excess rebreathed air (mainly nitrogen) which has accumulated in the breathing bag so that fresh oxygen can enter the breathing bag.

Note: How and when the pressure relief valve is used will be discussed later on in the "Wearing the Apparatus" section of this training module.

The pressure relief valve can be removed from the facepiece by unscrewing the washer-type retaining screw from inside the bottom of the facepiece. A wrench should be provided with the facepiece for unscrewing this retaining screw.

All-Vision Facepiece

Note: Omit this section if the team does not use the All-Vision facepiece.

Visual: Display the All-Vision facepiece and point out the following parts, and/or refer to both "Visual 14" and "Visual 15" for drawings of the facepiece.

Use these visuals as overhead transparencies, chalkboard sketches, or handouts.

The All-Vision facepiece is made of molded rubber and has a "split" or double lens. The facepiece is held in place by the head harness which has five adjustable rubber straps. By pulling on the ends of these straps once the facepiece is positioned over your face, you can snug up the facepiece and get a good face-to-facepiece seal around the edges.

On the inside of the facepiece, just below the lenses, are two air ducts. The oxygen-enriched air passes through these ducts when it enters the facepiece and flows across the inner surface of the lenses to help prevent fogging.

The All-Vision facepiece also has a few other parts which we will discuss in detail: the speaking diaphragm and the valve housing which contains the inhalation and exhalation valves and the pressure relief valve.

Valve Housing

At the bottom of the facepiece is a metal cylindrical unit known as the valve housing. This valve housing serves to connect the facepiece to the breathing hoses. It also houses the inhalation and exhalation valves and the pressure relief valve.

Inhalation and Exhalation Valves

The inhalation and exhalation valves are designed to help keep air flowing in a one-way direction. The inhalation valve, on the left side of the facepiece (when wearing) allows air to flow into the facepiece. The exhalation valve, on the right, permits air to flow out of the facepiece.

Demonstration: Remove the breathing hoses from the facepiece so as to expose the inhalation and exhalation valves. Then put on the facepiece and breathe, demonstrating how the valves open separately (as you inhale and exhale) to keep the air flowing in one direction. Be sure to reattach the hoses when finished.

Keep in mind that in a closed-circuit breathing apparatus it is very important to keep the air flowing in one direction only. If it didn't, you'd risk breathing in exhaled air filled with carbon dioxide, or else fresh oxygen might not reach you.

If you take these valves out of the valve housing and compare them, you will notice that each valve is constructed differently so that the inhalation valve will only fit the inhalation side of the valve housing, and the exhalation valve will only fit the exhalation side of the valve housing.

The inhalation and exhalation valves are also stamped with the letters IN and EX, respectively, to avoid confusion as to which valves they are.

Pressure Relief Valve

The pressure relief valve is the metal unit which extends from the bottom of the valve housing. The relief valve is a hand-operated valve that you open by pushing in on the plunger at the bottom of the unit. When the valve is open, air can be vented to the outside of the facepiece by blowing out through the valve.

If you have ever watched teams wearing McCaas, you may have noticed that they stop every 15 to 20 minutes to "blow off." This involves forcefully exhaling through the relief valve in order to purge the unit of nitrogen. The reason for this is that the McCaa does not automatically vent excess rebreathed air to the outside. So it is necessary for the wearer to "blow off" the excess rebreathed air (mainly nitrogen) which has accumulated in the breathing bag so that fresh oxygen can enter the bag through the admission valve.

Note: How and when the relief valve is used will be described later on in the "Wearing the Apparatus" section of this training module.

The pressure relief valve works in conjunction with another valve called the check valve. This check valve prevents the outside air from entering the facepiece when the pressure relief valve is open.

Demonstration: Unscrew the relief valve from the valve housing and point out the rubber gasket and spring as you discuss them in the following section.

The relief valve can be unscrewed from the valve housing. There is a rubber gasket at the threaded connection. Inside the relief valve housing there is a spring which keeps the relief valve shut except when manually opened.

When assembling the relief valve, always make sure the spring is placed correctly. Incorrect placement will foul the operation of the check valve.

Speaking Diaphragm

The All-Vision's speaking diaphragm is located in the round metal housing below the lenses. The speaking diaphragm, which is actually a thin, flexible disc, vibrates in order to transmit your voice to the outside when you speak with the facepiece on.

You can easily remove the speaking diaphragm by unscrewing the retaining ring from the diaphragm housing and taking out the parts that make up the diaphragm assembly.

Demonstration: Unscrew the retaining ring from the speaking diaphragm assembly and take the diaphragm assembly apart piece by piece as you describe each part below. *The parts are labeled on "Visual 15" for your reference.*

The diaphragm assembly consists of several parts:

1. A retaining ring;
2. A metal front guard (primarily a flame arrestor);
3. A plastic spacer ring;
4. The diaphragm; and
5. A perforated metal disc with a rubber gasket around it.

Demonstration: Reassemble the diaphragm assembly within the housing as you describe the following functions of each part.

The rubber gasket around the perforated metal disc provides a seal between the metal housing and the diaphragm.

The spacer ring exerts pressure on the parts contacting the rubber gasket, ensuring an airtight seal when the retainer ring is tightened in place.

The front guard protects the pastic diaphragm from external damage and acts as a flame or spark arrestor.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. Describe the purpose of the safety cap on the oxygen cylinder.

   (Answer: The safety cap allows oxygen to safely escape from the oxygen cylinder without rupturing the cylinder (in case the cylinder is exposed to excessive heat or pressure).)

2. What is the function of the bypass valve and when is it used?

   (Answer: The bypass valve, when open, permits oxygen to bypass the reducing valve, allowing the oxygen to go directly to the breathing bag at high pressure. It is used when the automatic system malfunctions.)

3. What is the function of the safety valve?

   (Answer: The safety valve releases oxygen when the reducing valve is not working properly and functions as a warning whistle as it vents the excess pressure.)

4. What should you do if the safety valve whistle sounds while you are wearing the apparatus?

   (Answer: Close the main cylinder valve and obtain your oxygen by manually opening and closing the bypass valve. Return to fresh air immediately.)

5. At what pressure should the safety valve begin to operate?

   (Answer: Between 7 and 9 PSI.)

6. What should you do if the pressure gauge or gauge line develops a leak while you are wearing the apparatus?

   (Answer: Close the gauge valve and return to fresh air as soon as possible.)

7. What is the purpose of the pressure relief valve in the facepiece?

   (Answer: It permits the wearer to "blow off" excess rebreathed air to purge the unit of nitrogen which has accumulated in the breathing bag so that fresh oxygen can enter the breathing bag.)

8. (For the All-Vision facepiece only) What is the purpose of the check valve in the All-Vision facepiece?

   (Answer: It prevents outside air from entering the facepiece when the relief valve is open.)

THE BREATHING CIRCUIT

Objective 3: The team members will describe the breathing circuit of the McCaa apparatus.

Visual: Use an apparatus as an aid in describing the following air flow through the apparatus, and/or refer again to "Visual 2" for a cutaway view of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Now that we've looked at all the parts of the apparatus, we can trace the flow of air through the apparatus and see exactly how the system works.

When you inhale, oxygen-enriched air is drawn out of the breathing bag and cooler, through the inhalation hose, and into the facepiece where it is inhaled.

When you exhale, the air goes out the exhalation hose and back into the apparatus. The air enters the regenerator at the left side and moves to the right, through the Cardoxide, where the carbon dioxide is absorbed.

The purified air (exhaled air minus the carbon dioxide) then leaves the regenerator on the right side, and enters the cooler. The baffle plate that divides the cooler forces the air to make a complete circulation of the cooler before the air is inhaled again. This helps to cool the air.

Fresh oxygen is periodically admitted to the breathing bag and cooler to "enrich" the recirculated air. The high-pressure oxygen travels from the cylinder through the reducing valve where its pressure is reduced to intermediate pressure (3 to 4½ PSI).

The intermediate pressure oxygen then goes through oxygen supply line to the admission valve. When the admission valve is open, the oxygen enters the breathing bag and cooler, mixing with and enriching the purified recirculated air, at low or breathable pressure (at least ½ PSI).

The oxygen-enriched air is then drawn out of the bag and cooler as you inhale again.

Of course when the bypass valve is used, the oxygen does not go through the reducing valve. Rather, it goes around the reducing valve, traveling through the bypass line directly to the cooler at high or bottle pressure.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. Where does fresh oxygen mix with the purified air from the regenerator?

   (Answer: The purified air mixes with fresh oxygen in the breathing bag and cooler.)

2. What happens in the regenerator?

(Answer: The Cardoxide in the regenerator removes the carbon dioxide from the exhaled air.)

3. What purpose does the baffle plate in the cooler serve?

(Answer: The baffle plate divides part of the cooler, functioning to force the recirculating air to make a complete circulation of the cooler before the air is inhaled again. This helps to cool the air.)

PUTTING ON THE APPARATUS

Objective 4: The team members will put on and take off the McCaa apparatus correctly and check it for proper functioning.

Mouthpiece note: Refer to the *Appendix* for the lecture "Putting On the Apparatus and Mouthpiece."

Before putting on your apparatus, make sure that all the necessary tests and maintenance have been performed on it. The apparatus must have a properly charged oxygen cylinder in it, along with fresh Cardoxide in the regenerator.

Note: Testing and maintaining the apparatus will be covered in detail later on in the "Bench Duties" section of the module.

When all of these things have been taken care of, you are ready to put on the apparatus.

Demonstration: As you discuss the following procedure, demonstrate how to put on the apparatus. Either do it yourself or have a team member put it on as you describe each step.

To put on the apparatus properly:

1. **First, visually inspect the protective cover, harness, hoses, and facepiece to make sure they are in good condition.**

2. **Fully assemble the apparatus by attaching the breathing hoses and facepiece to the apparatus. Remember, the longer rigid hose is the exhalation hose and it connects to the regenerator.**

3. **Apply antifog to the inner and outer surfaces of the facepiece lens.**

Note: "Fogpruf" and "Fogpruf P" are MSA's brand names for antifog solution. *"Fogpruf P" is the only one of these two solutions that can be used on the Ultravue's plastic lens.*

4. **With the apparatus fully assembled, you are ready to put on the unit. Slip your arms through the shoulder straps one at a time. Once you have the apparatus on your back, adjust the shoulder straps for a comfortable fit. Then buckle the waist belt and chest strap for a snug fit. Make sure to fasten the rigid hoses to the chest strap before you buckle the strap.**

5. Open the main cylinder valve all the way.

6. Put on the facepiece. The recommended procedure for putting on the facepiece is to fully extend the head harness and put your face into the facepiece, chin first. Position the mask over your face, making sure that your hair does not interfere with the facepiece seal. Position the head harness straps around the back of your head and tighten them, starting with the lower straps. These straps should be adjusted to provide a comfortable fit and a good face-to-facepiece seal.

Once you have the facepiece on, there are four things you have to do immediately, before you can safely use the apparatus:

1. Check the facepiece seal and one-way valves (inhalation and exhalation valves, and relief valve);

2. Purge all the normal air from the apparatus and flush the apparatus with fresh oxygen;

3. Check the bypass valve; and

4. Check the pressure gauge.

Checking the Facepiece Seal and One-Way Valves

Demonstration: Have someone demonstrate the following procedures as you describe them below.

To test the inhalation valve and the facepiece seal: Tightly squeeze the exhalation hose (on the right while wearing) and attempt to exhale. No air should pass out of the facepiece through the inhalation valve, indicating that the one-way inhalation valve is working properly (it does not allow you to exhale through it).

Also, pressure should build up in the facepiece with no air leakage indicating a good face-to-facepiece seal.

To test the exhalation valve, pressure relief valve, and facepiece seal: Tightly squeeze the inhalation hose (on the left when wearing) and open (push) the pressure relief valve. At the same time, try to inhale slowly, yet forcibly. No air should come into the facepiece through the exhalation valve or the relief valve, indicating that these one-way valves are working correctly (they do not allow air to come into the facepiece).

The facepiece should collapse against your face indicating a good face-to-facepiece seal.

Purging the Apparatus and Flushing with Oxygen

With the main cylinder valve shut, you are now going to "purge" all the normal air from the apparatus to amke room for fresh oxygen. This procedure involves inhaling air from the apparatus and exhaling it to the outside through the pressure relief valve until the apparatus is completely emptied. Then you are going to open the oxygen cylinder valve and continue to purge air through the relief valve to flush the apparatus with oxygen.

To perform this procedure:

1. Close the cylinder valve;

Note: Team members may wish to keep their right hands on the cylinder valve to eliminate the panic factor when the apparatus is evacuated.

2. Inhale from the apparatus and hold your breath;

3. Squeeze the exhalation hose shut;

4. Open the pressure relief valve; and

5. Exhale forcibly through the relief valve to the outside.

Note: It is suggested that team members bend over from the waist as they exhale. This process of bending over helps one to exhale more forcefully and completely.

Repeat this procedure until the apparatus is completely emptied of air. You should be aware that you are also testing the relief valve during this procedure making sure that it does, when open, release the air as you exhale through it.

When the apparatus is emptied of air, open the main cylinder valve completely and lock it in position by attaching the safety chain.

Note: The chain, remember, prevents the main valve from being accidentally closed.

Now repeat the procedure of inhaling from the apparatus and exhaling through the relief valve to get oxygen from the cylinder to flush the apparatus. You should repeat this procedure at least three times in order to get oxygen to completely fill the apparatus.

Note: Again, it is suggested that the team members bend over as they exhale.

This process of purging the apparatus of normal air and flushing the apparatus with oxygen is extremely important. If you do it properly, a large amount of nitrogen will be expelled from the apparatus and you will be provided with air containing a high percentage of oxygen.

Checking the Bypass Valve

Open the bypass valve momentarily to make sure it is working properly. You should be able to hear the flow of oxygen.

When you're finished with the test, make sure that you completely close the bypass valve. A partially open valve will waste oxygen and cause a pressure buildup in the apparatus.

Checking the Pressure Gauge

Finally, check the pressure gauge to make sure that the gauge valve is open and to make sure that you have 150 atmospheres of oxygen in the cylinder.

TAKING OFF THE APPARATUS

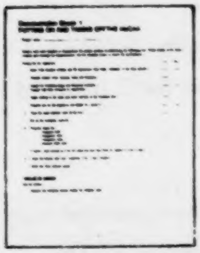
Mouthpiece note: Refer to the *Appendix* for the lecture, "Taking Off the Apparatus and Mouthpiece."

Demonstration: As you discuss the following procedure, demonstrate how to properly take off the apparatus.

The proper method of removing the apparatus is:

1. **First, loosen the head harness straps and remove the facepiece.**
2. **Close the main cylinder valve.**
3. **Unfasten the harness's waist and shoulder straps, loosen the shoulder straps and slip the apparatus off your back.**

Demonstration check: Have the team members put on the apparatus, check it for proper functioning, and take off the apparatus. Use copies of *Demonstration Check 1 – Putting On and Taking Off the McCaa,* provided at the back of this module to check each team member's performance. Review the results with each team member.



WEARING THE APPARATUS

Objective 5: The team members will define the limitations of the apparatus when it is worn and practice wearing the apparatus.

Limitations

We talked generally, in the Introduction to Self-Contained Breathing Apparatus module, about some of the limitations placed on you when you wear an apparatus. Understanding these limitations and learning to cope with them can have a significant effect on how well you do your job.

Note: At this point you may wish to review the general limitations from the *Introduction to Self-Contained Breathing Apparatus* module (MSHA 2003).

We'll look now at specific limitations of the McCaa. You should be thinking about these limitations, and learn to deal with them during training sessions. When you're working on a rescue operation, you're going to want to work as naturally and efficiently as possible.

Time Limit, Work Rate, and Breathing Rate

The McCaa apparatus is approved under Schedule 13 of the former Bureau of Mines program for 2 hours of use.

The air you breathe while wearing the apparatus may get very warm and have a lot of moisture in it. The McCaa's "cooler" helps to keep the air temperature low enough to prevent discomfort to you. However, if you work hard or the mine is hot, the air you breathe may get uncomfortably warm.

Breathing the warm, moist air can add additional stress to your job especially when you're working extremely hard.

Note: You might wish to mention that the extra stress this creates is something akin to working on a hot, humid day vs. doing the same work on a cool, dry one.

Mouthpiece note: The following paragraph pertains to the facepiece. Omit it if the team uses a mouthpiece.

The heat and moisture produced within the unit can also cause the facepiece lens to fog, making it difficult for you to see. This is why you should always use an antifog solution on the lens before you put on the facepiece. This solution prevents moisture from adhering to the lens.

Size and Weight of Apparatus

The McCaa apparatus weighs about 39 pounds (about 17½ kilograms) with a fully charged oxygen cylinder in it, and is about 24 inches long and 16 inches wide (61 cm x 41 cm). Working and moving with this extra bulk and weight is something you will have to get used to during your training sessions.

Your movement will be somewhat slower and maneuverability will be restricted with the apparatus on your back, especially in tight places.

Mouthpiece note: Refer to the *Appendix* for "Mouthpiece Limitations."

Checks to Make While Wearing the Apparatus

After putting on your apparatus and preparing it for use, you are ready for rescue work or training. The McCaa will function automatically while you work, providing you with oxygen-enriched air as you need it. The only things you will have to do "by hand" are:

1. "Blow off" the accumulated rebreathed air (mainly nitrogen) from the apparatus every 15 to 20 minutes;
2. Check the pressure gauge;
3. Use the bypass valve if you are not getting enough oxygen or if the safety valve whistle sounds; and
4. Check the admission valve if you suspect that it is not working properly.

Of course, your captain will stop the team periodically to blow off and check to see how each member is doing. During this check, the captain will also check your pressure gauge reading, and inspect your facepiece and wearing harness.

Blowing Off

Note: This procedure is also known as a "blowdown."

As I explained earlier, the process of "blowing off" gets rid of the nitrogen which accumulates in the breathing bag. Normal breathing air is 78 percent nitrogen. Although it is not poisonous, nitrogen can build up in the breathing bag and dilute the otherwise purified oxygen within the bag, so it should be eliminated.

In order to effectively eliminate the nitrogen while wearing the apparatus, you must blow off every 15 to 20 minutes. The procedure for blowing off is the same procedure you use when you put on the apparatus and flush it with oxygen:

1. Inhale from the apparatus and hold your breath;

2. Squeeze the exhalation hose (on the right) shut;

3. Open the pressure relief valve; and

4. Exhale forcefully through the valve to the outside air.

Note: It is suggested that team members bend over from the waist as they exhale. This process of bending over helps one to exhale more forcefully and completely.

This procedure must be repeated three times in order for it to be complete.

Usually "blowing off" is done together as a team during the team check.

Checking Pressure Gauge

When you make these stops to "blow off," you should also check your pressure gauge. There is no warning alarm on the McCaa to warn you when you are nearing the end of your oxygen supply, so you will have to periodically check your cylinder pressure in order to notice when you are getting low on oxygen.

Note: Many teams use 60 atmospheres as a guideline for when to return to fresh air.

Using Bypass Valve

If you are not getting enough oxygen while wearing the apparatus, you should obtain oxygen by manually opening and closing the bypass valve as you need oxygen until you reach fresh air.

If your safety valve whistle sounds, indicating a malfunctioning reducing valve, close the main cylinder valve and obtain oxygen by manually opening and closing the bypass valve until you reach fresh air.

Because the bypass valve sends high pressure oxygen directly to you, using it more than necessary wastes oxygen. Never use it just to "cool" or "freshen" the oxygen you breathe. Use the bypass valve only when absolutely necessary–and when you do, use it sparingly.

Checking Admission Valve

If you suspect that your admission valve is sticking while you're wearing the apparatus, have a team member check the valve by reaching in through the hole in the cover and pushing in on the breathing bag's bumper plate to unstick the admission valve. You should be able to hear the oxygen flow through the valve.

If the valve is not working and you are not getting oxygen, use the bypass valve and return to fresh air immediately.

Note: Indiscriminate use of the bypass or depressing of the admission valve can result in the apparatus being overpressurized.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with the team so they fully understand the material covered in the "Wearing" section.

1. While wearing the apparatus you must stop every 15 to 20 minutes to blow off. Explain why and how you do this.

   (Answer: You must blow off to get rid of accumulated nitrogen from the apparatus. The procedure for blowing off is to:

   a. Inhale from the apparatus;

   b. Squeeze the exhalation hose shut;

   c. Open the pressure relief valve; and

   d. Exhale forcefully through the valve to the outside.

   This procedure has to be repeated three times.)

2. How will you know when you are low on oxygen?

   (Answer: Since the McCaa does not have an automatic alarm to warn you when your oxygen supply is low, you have to frequently check the pressure gauge (every 15 to 20 minutes) to see when you are getting low on oxygen.

3. The air in the McCaa tends to become warm and moist as it is recirculated again and again. What effect does this have on the wearer?

(Answer: Breathing warm, moist air can add more stress to the wearer's job, especially when hard work is being done. Also warm, moist air can cause the facepiece to fog up.)

4. How does wearing an apparatus affect your movement?

   (Answer: Your movement is slower, maneuverability is limited, and you may not be able to fit in tight places.)

Wearing Schedule

Note: A *Suggested Wearing Schedule* for the apparatus is included at the back of this module. It presents a three-session practice schedule of exercises and procedures for wearing the apparatus. It is recommended that these practice sessions be conducted after you have finished presenting the training contained in this module.

BENCH DUTIES

Objective 6: The team members will perform required and recommended testing and maintenance of the McCaa apparatus.

Note: The rest of this module is about apparatus testing and maintenance. Since testing and maintenance programs differ from one mine to another, this section is designed so that you can adapt it to fit your own training needs. Simply use the sections that fulfill your training needs, and leave out those that don't.

When you're under oxygen, every move you make depends on the smooth and proper operation of your breathing apparatus. That's why it is important to keep your apparatus in top condition. You can keep it operating properly only by testing and maintaining it on a regular basis.

Cleaning and Disinfecting the Apparatus

After each time you wear the McCaa the regenerator must be cleaned out and the facepiece and hoses must be cleaned and disinfected.

To prepare the apparatus for cleaning after wearing it:

Demonstration: Demonstrate the following procedures as you describe them. Either demonstrate them yourself or have a team member do it.

1. **Disconnect the facepiece and hoses from the apparatus. Separate the rigid from the flexible breathing hoses; and**
2. **Remove the cover and oxygen cylinder from the apparatus.**

To clean out the regenerator:

Note: You will need to use the special ***two-pronged flat wrench*** (provided with the apparatus) and a ***brush*** for the following step.

1. **Turn the apparatus on its side so that the regenerator cap is on top. Unscrew the cap using the special two-pronged flat wrench provided with the apparatus.**

2. **Shake out the used Cardoxide.**

3. **With a brush, reach in and brush out any small particles that may be stuck in the regenerator. You should be careful to clean out all the Cardoxide.**

4. **When all the particles have been removed, you can replace the regenerator cap loosely.**

To clean and disinfect the facepiece and all the breathing hoses:

1. **Wash all the hoses and the facepiece thoroughly in a cleansing solution.**

   The speaking diaphragm should be taken apart and each part should be washed.

   The inhalation and exhalation valves should be periodically removed from the hoses and cleaned and disinfected.

To remove the valves: Loosen the screw clamps. Take off the hoses and slide the valves out. Do not take the valves out of the housings. Inspect the valves within the housings to see if they're in good condition and replace them if necessary.

If the valves are in good condition, clean the valve housings and valves in the cleansing solution.

4. All the washed pieces should then be put in a disinfectant solution. This solution must be recommended for sterilization of rubber and metal parts and must be properly diluted. Otherwise the parts will deteriorate and have to be replaced more often.

5. Then rinse all the sterilized pieces in clear, warm water to remove all the disinfectant solution.

6. The pieces should then be dried thoroughly. If possible, hang the facepiece and hoses from a line in a dry, well-ventilated room away from direct sunlight and fluorescent light. Both sunlight and fluorescent light can harm the rubber parts.

   The parts of the speaking diaphragm and the inhalation and exhalation valves should be laid out on a table so the water can easily drain out of them.

   If it is not practical to let the parts air-dry, you can use a blowdryer if it is set on a cool temperature (not above 140° F, 60° C) to dry the parts more rapidly. You should, however, not use compressed air to dry the parts because compressed air could deposit oil on the parts.

7. When all the pieces of the speaking diaphragm are dry, you can put the speaking diaphragm back together in the facepiece.

Visual: If necessary, refer to either "Visual 13" (Ultravue) or "Visual 15" (All-Vision) for a picture of how the speaking diaphragm fits together.

8. When the inhalation and exhalation valves are dry, put them back into the facepiece assembly. Be careful to put the exhalation valve on the exhalation side of the facepiece and the inhalation valve on the inhalation side of the facepiece.

As for cleaning the outside of the apparatus, you should occasionally wipe down the cover and harness with a damp cloth.

Storing the Apparatus

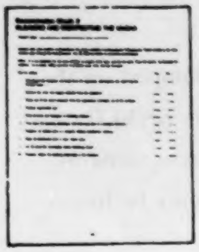
You should be careful to keep the parts of the apparatus as free as possible from moisture and dirt. To protect the apparatus from dust, dirt, and moisture, you should keep it in the storage/carrying case whenever you are not using it.

When packing the apparatus in the case be careful not to distort the rubber parts. The facepiece should have a spreader installed for storage.

Always store the apparatus in a convenient location so that they will be ready for immediate use.

Note: 30 *CFR*, Section 49.6(b) requires that apparatus be stored and maintained in a manner that will ensure readiness for immediate use.

Demonstration check: Have each team member clean and disinfect the apparatus. Use copies of *Demonstration Check 2–Cleaning and Disinfecting the McCaa,* provided at the back of this module to check each team member's performance. Review the results with each team member.



Oxygen Cylinders

Oxygen cylinders are designed to contain oxygen under high pressure. For that reason they must be in good condition and properly handled and stored at all times.

Before the cylinders leave the factory, they must meet the construction specifications of the Department of Transportation (DOT) and be rigidly tested by an independent inspector licensed and certified by DOT. Then, after the cylinders leave the factory, they must be retested hydrostatically every 5 years.

Note: When a cylinder is hydrostatically tested, it is filled with water to a pressure greater than its normal operating pressure, forcing the cylinder to expand. The hydrostatic test measures the elasticity of the cylinder as the cylinder expands.

Hydrostatic Testing

Hydrostatic testing is important because it will reveal any inside deterioration of the cylinder. One cause of inside deterioration is moisture in the cylinder.

Moisture is carried into the cylinder when the cylinder is filled with oxygen. The moisture hastens oxidation of the steel bottle causing sediment, rust, and pitting, and weakening of the cylinder walls. These changes occur with no visible signs on the outside of the cylinder. Hydrostatic testing is the only way to determine the complete condition of the cylinder.

The date of the hydrostatic test is stamped on the outside of the cylinder (usually near the neck) for easy reference in determining when the cylinder must be tested again. Remember, the cylinder must be hydrostatically tested every 5 years.

Visual: Display an oxygen cylinder and point out where the hydrostatic test date is located. Also point out where the pressure service rating is stamped as you discuss the following section.

Pressure Service Rating

Also stamped near the neck of the cylinder is the pressure service rating. The pressure service rating is the maximum pressure in pounds per square inch (PSI) that the cylinder is approved to hold.

The McCaa cylinder's pressure service rating is 2265 PSI.

Sometimes there is also a plus sign (+) stamped on the cylinder next to the hydrostatic test date. If this "plus" is stamped next to the most recent hydrostatic test date, it means the cylinder can hold 10 percent more than the pressure service rating. The cylinder should never be filled beyond the total service pressure marked on it.

Note: Each time the cylinder is retested it may or may not obtain the "+" rating. The "+" rating. The "+" must be stamped *each time* the cylinder is tested (if it is "+" rated). It is important that the team know this.

Handling and Storing the Cylinders

Oxygen can be dangerous near fire or sources of ignition (such as a lit cigarette). Oxygen causes a flame to burn with more intensity. In effect, it can "feed" a fire. So It is very important that combustible materials and sources of ignition be kept away from the area where you are filling or storing oxygen cylinders.

No open flames should be around oxygen and smoking must be prohibited. No hydrocarbon oil, grease, or combustible materials should be used or stored around oxygen equipment.

All equipment used for filling cylinders, such as an oxygen pump, connections, hoses, cylinders, and the apparatus itself must be clean and free of oil and grease or unapproved lubricants.

The area where oxygen cylinders are filled and stored must have adequate ventilation to prevent a buildup of oxygen and reduce the potential for fire.

If the cylinders are stored outside the apparatus they should be put in racks or held in place by chains so that they do not fall over or onto the floor. And the room or area that the cylinders are stored in should have a temperature of about 70° F (21° C).

If handling cylinders, use caution. Be careful not to drop or knock over a cylinder.

Don't use a wrench or hammer to open or close a cylinder valve. The valve should only be tightened or untightened by hand.

Finally, when being transported outside the apparatus, cylinders should be secured. The valve should be tight and have the cylinder cap screwed on.

Filling Oxygen Cylinders

There are two methods of filling oxygen cylinders at a mine site: the cascade system and the high-pressure oxygen pump.

Reference: The reference for the following regulation regarding what method of filling to use is 30 *CFR*, Section 49.6(a)(4).

The cascade system can be used to recharge a cylinder when the cylinder's pressure service rating is 2400 PSI (163 atmospheres) or less.

The high-pressure oxygen pump (also called a booster pump) is generally used to recharge a cylinder to higher pressures but can be used for lower pressures. Nevertheless the high pressure pump must be used when the cylinder's pressure rating is above 2400 PSI (163 atmospheres).

Since the McCaa's cylinder has a pressure service rating of 2265 PSI (154 atmospheres), plus a possible 10 percent more (2491 PSI, 170 atmospheres), either the cascade system or the oxygen pump can be used to charge the cylinder.

Note: The next section of the lecture covers *general* procedures and precautions to be followed when filling the oxygen cylinders. For more detailed information on the cascade or high-pressure pump system, refer to manufacturer's information or the Bureau of Mines', *Mine Rescue Apparatus and Auxiliary Equipment: A Handbook for Miners* by Morrow, Demkowicz, and Chastain.

When filling a cylinder, use only United States Pharmacopoeia (USP) medical oxygen. Other grades of oxygen may contain impurities or excessive moisture that can affect the cylinder's operation.

Before filling a cylinder with oxygen, you should look over the cylinder and check some things to make sure the cylinder is in good condition:

1. **Inspect the cylinder for dents and corrosion. A badly corroded cylinder could rupture under pressure. Damaged cylinders should be returned to the manufacturer.**

2. **Check the hydrostatic test date and the pressure service rating stamped on the cylinder. Remember, a cylinder is only good for 5 years after it has been tested. If it has been more than 5 years, the cylinder must be hydrostatically retested.**

   Also remember that the cylinder cannot be filled beyond its pressure service rating.

3. **During training, you should try to maintain at least 500 PSI (34 atmospheres) in the cylinder at all times. If this small amount of pressure is not maintained in the cylinder, outside air and moisture could enter the cylinder and foul the oxygen or cause the inside of the cylinder to corrode. Particles of corrosion could then enter the apparatus and foul it.**

If you have an oxygen cylinder showing zero pressure on the gauge, it should be marked or tagged as empty and returned to the manufacturer or a certified testing facility to be purged and vacuumed to remove moisture and contaminants.

Also the valve on an empty cylinder should be kept closed to prevent further contamination in the cylinder.

If you're using a high-pressure pump to fill the cylinder, the pump should have a filter dryer installed on the gas inlet side of it to prevent moisture or dust from getting into the oxygen. The filter should be changed or refilled regularly.

4. Before filling the cylinder it is a good practice to crack the cylinder valve slightly and then close it. This will blow out any dust and moisture that may have accumulated in the valve. When doing this, make sure the valve opening is pointed away from your face to avoid getting dust or dirt blown into your eyes.

When filling bottles at high pressures they should be placed in a strong container or holder to prevent injury in the event the bottle busts or explodes.

Also, when filling the cylinders, the temperature in the room or area you are working in should be about 70° F (21° C). The reason for this is because oxygen expands in higher temperatures. If you fill a cylinder in a very warm room, the oxygen expands to a high pressure. If this filled cylinder is then stored in a cool room, the oxygen will contract to a lower pressure and it won't be a fully charged cylinder when you're ready to use it.

The reverse could also happen: If you fill a cylinder in a cool room and then store it in a warm place, the oxygen will have a tendency to expand as the pressure increases in warmer temperatures. And the increasing pressure could go beyond the pressure service rating for that cylinder.

Note: Some brands of pumps are equipped with a safety feature which automatically shuts off the pump at a preset pressure.

You also have to avoid heating up the oxygen as you fill the cylinder. If you fill a cylinder too quickly, heat is produced, causing the oxygen to expand to a higher pressure. Then after the oxygen cools down, the pressure drops and the cylinder is no longer filled to the correct pressure.

If you use a high-pressure pump to fill the cylinder, the temperature in the cylinder will rise according to how fast the pump is working. After filling the cylinder, let it cool for 15 to 20 minutes. The pressure reading on the cylinder will probably drop. If so, fill the cylinder once more to the correct pressure.

If the cylinder is going to be stored or transported outside of the apparatus, attach the cylinder cap to the cylinder valve connection to keep dust and moisture from getting into the valve and to protect the coupling threads. The cap should be kept screwed on the cylinder valve and removed only when the cylinder is being filled or when it is connected to an apparatus.

Note: Oxygen cylinders should only be filled with oxygen. Do not use an oxygen cylinder for storage of any other type of gas.

Cardoxide

Cardoxide is a soda lime chemical mixture which, when used in an apparatus, absorbs carbon dioxide from air which is forced through the regenerator.

Cardoxide cannot be used more than once in an apparatus whether it is used for 10 minutes or 2 hours. The Cardoxide should be emptied out of the regenerator immediately after the apparatus has been worn.

The Cardoxide is packaged and shipped in cans which hold a little bit more than the 4 pounds (1.7 kilograms) that the regenerator holds. So, one can of Cardoxide fills one regenerator. It is important to keep the cans completely sealed until it is time to pour the Cardoxide into the regenerator. Cardoxide from a can that has been left open may not be any good.

Filling the Regenerator

Filling the regenerator with Cardoxide is done just before you wear the apparatus. The Cardoxide cannot be stored in the regenerator. If it has been stored in the regenerator, it may not work as it should to absorb carbon dioxide.

The steps for filling the regenerator with Cardoxide are:

Demonstration: Demonstrate the following steps for filling the regenerator. Either demonstrate it yourself or have a team member do it as you describe the procedure.

1. Take off the protective cover and remove the oxygen cylinder.

2. Place the apparatus on its side so that the regenerator cap is on top. Unscrew the cap (using the two-pronged flat wrench which should be provided with the McCaa). Be careful not to let the apparatus rest on the reducing valve when on its side because the valve is easily damaged.

3. Check the inside of the regenerator to make sure it is completely empty of any used Cardoxide. If there are particles of Cardoxide still in the regenerator, brush or shake them out.

Note: You may wish to use a funnel when filling the regenerator.

4. Then pour in the Cardoxide and tap the sides of the regenerator to help pack the Cardoxide and eliminate air spaces within the regenerator. Fill the regenerator all the way to the top.

   Sometimes Cardoxide dust is formed in the storage cans due to transportation or storage. This dust should not be put into the regenerator. Some of it might enter the apparatus and be inhaled by you. It is therefore advisable to screen the Cardoxide to get rid of the dust and small particles before pouring the Cardoxide into the regenerator.

5. After the regenerator is completely full, examine the rubber gasket on the regenerator cap to make sure it is clean and in good condition.

6. Finally, replace the regenerator cap and tighten it firmly using the two-pronged flat wrench.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with the team so they fully understand the material covered in the "Oxygen Cylinders" and "Regenerator" sections.

1. When using the cylinders, why should at least 500 PSI (34 atmospheres) of oxygen be left in the cylinders (instead of them being empty)?

(Answer: Because outside air and moisture could get into an empty cylinder and foul the oxygen or cause the inside of the cylinder to corrode. Particles of corrosion could then enter and foul the apparatus.)

2. **What kinds of things should you check and do before filling a cylinder?**

   (Answer:

   (1) Inspect the cylinder for dents and corrosion;

   (2) Check the hydrostatic test date and the pressure service rating stamped on the cylinder;

   (3) Make sure the cylinder is not completely empty;

   (4) Crack the cylinder valve slightly to blow out dust and moisture from the valve.)

3. **When filling a cylinder, what should the temperature be in the room or area where the cylinder is being filled, and why?**

   (Answer: The temperature should be about 70° F (21° C) in order to get a completely and safely filled oxygen cylinder. Otherwise, if the temperature in the room or area is too high or too low, the oxygen will contract or expand, respectively, when the cylinder is stored (creating either an underfilled or overfilled cylinder).)

4. **What safety precautions should you observe in an area where you are filling oxygen cylinders?**

(Answer: No smoking or open flames; no oil, grease, or combustible materials; all the equipment and cylinders should be clean; and there should be adequate ventilation in the room.)

5. **How much Cardoxide is needed to fill the regenerator?**

(Answer: Approximately 4 pounds (1.7 kilograms) of Cardoxide or the contents of one storage can.)

6. **Can Cardoxide be reused in an apparatus?**

(Answer: No, Cardoxide can be used only once in the apparatus, whether for 10 minutes or 2 hours. It should be emptied out of the regenerator immediately after the apparatus has been worn.)

Testing the Apparatus

Note: Depending on how your training program is set up, the team members may or may not be responsible for testing their own apparatus and keeping records. You may leave out information in the next sections that doesn't apply to your program. *However, it's important for all the team members to know what the law says with regard to inspection and recordkeeping.*

As you have seen thus far, there are a lot of parts and functions on the McCaa breathing apparatus. Every one of these parts must, at all times, be in good to perfect condition and every function must work precisely as it was designed to work. If there is less than perfect operation anywhere, the apparatus will work either less efficiently or not at all. And if the unit doesn't function properly, neither will you.

To help assure correct functioning, you must test and inspect the apparatus regularly. Testing is an important part of using the apparatus, for just as you wear the apparatus, you must also test it regularly.

Federal law requires that the apparatus be tested and inspected at least once every 30 days.

Reference: The reference for testing and inspecting requirements is 30 *CFR*, Section 49.6(b).

Also, the apparatus should be tested before it is worn for actual rescue work especially if it has been transported to the mine site. A trip down a bumpy road in a truck could loosen couplings or otherwise cause the apparatus to function improperly.

And don't think that there isn't enough time to test the apparatus before going to a rescue. You have to make the time. Once you become experienced with the test procedure you should be able to run through it quickly and accurately. Afterwards, when you're wearing the apparatus and you're counting on it for oxygen, you'll be confident that your unit is dependable.

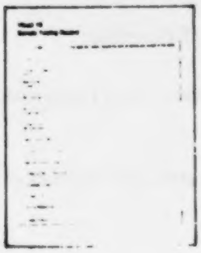
Recordkeeping

Keeping records of tests and repairs made on your apparatus is an important means of ensuring that your unit is always dependable. Accurate, well-kept records can tell you at a glance what condition your unit is in. When kept over long periods of time, records help to identify your unit's "weaknesses" and help you spot minor trouble areas that could turn into major malfunctions. Records also provide you with a basis for developing a replacement schedule for expendable parts.

Testing Records

Visual: Refer to "Visual 16" for a picture of a sample testing record.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Federal law requires that you maintain a record of all tests and inspections performed on the apparatus. This record must be kept at the mine for a period of one year.

Reference: The reference for testing and inspection records is 30 *CFR*, Section 49.6(b).

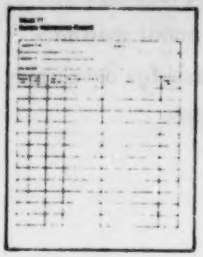
This record, which may be designed as a checklist, should include all the tests and inspections performed on the apparatus. It should also include the test date, the name of the person performing the tests, and the serial number of the apparatus.

The testing record should also note what parts, if any, need to be replaced.

Maintenance Records

Visual: Refer to "Visual 17" for a picture of a sample maintenance record.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



In addition to the testing and inspection record required by law, it is also a good idea to keep a separate maintenance record for each apparatus.

A maintenance record should include, if possible:

1. **The total number of hours the apparatus has been used;**
2. **The installation dates for any new parts that have been put on the apparatus; and**
3. **The date on which the apparatus was first placed in service.**

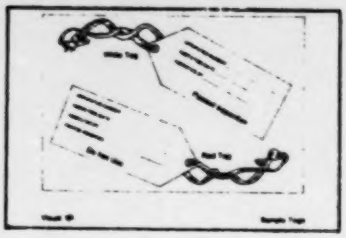
A record like this one helps you establish a regular maintenance program for each apparatus.

Note: At this point, discuss your mine's schedule for and/or experience with replacing expendable parts such as hoses, breathing bags, washers, etc.

Tagging

__Visual__: Refer to "Visual 18" for a picture of sample tags.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



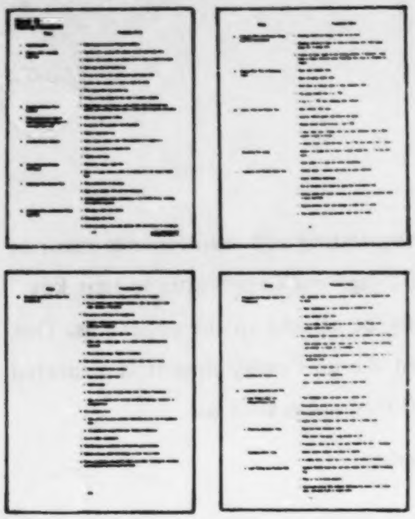
In addition to keeping testing and maintenance records, it's also a good idea to "tag" each apparatus so that key information can actually be affixed to the apparatus. This tag should be placed on the unit every time it is inspected and it should include information such as:

1. The apparatus number;
2. The most recent test date;
3. The name or initials of the person who tested the apparatus;
4. Any parts that have been removed for repairs; and
5. Whether or not the apparatus is ready for use.

It is suggested that a __white tag__ be used if the apparatus has passed all inspection tests and is ready for use. If the unit is not functioning properly or has a part removed for repairs, a __red tag__ should be used. Thus, you will know immediately by the color of the tag whether the apparatus can be used.

Testing Procedure

Visual: Distribute copies of the "Visual 19" handout which is a guide to the following testing procedure. Refer the team members to it as you discuss each of the following tests. You may also use an overhead transparency of the visual.



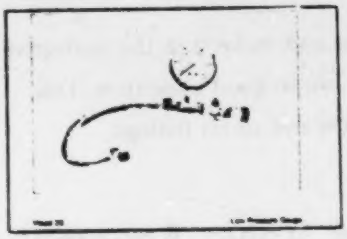
There are 14 steps in the testing procedure for the McCaa, starting with a visual inspection of the wearing harness and cover. The steps fall into four main groups:

1. Visual inspection;
2. Testing the oxygen supply parts;
3. Testing the facepiece; and
4. Testing the complete apparatus.

The only special equipment you will need to test the apparatus is a low-pressure test gauge (15 PSI) and a leak-finding solution (such as soapsuds).

Visual: Point out what the low-pressure gauge looks like, and/or refer to "Visual 20" for a drawing of the gauge.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Demonstration: *For each of the following steps of the testing procedure, demonstrate the procedures as you describe them in the lecture.* This will help the team understand how to perform the tests. Either demonstrate the procedures yourself or have a team member do it as you describe the procedures.

You should begin the tests with 165 atmospheres of oxygen in the cylinder, provided the cylinder is stamped with a plus sign (+) to indicate it will hold 10 percent more than 150 atmospheres. The reason the cylinder should have 15 atmospheres more than the normal 150 atmospheres is to allow extra oxygen for the tests.

Step 1: Visual Inspection

Take everything out of the storage box so that the apparatus, facepiece and breathing hoses are laid out in front of you. Make sure that you have antifog solution and wiping tissue for the facepiece lens.

Look over the apparatus and make sure the protective cover and wearing harness are in good condition. This includes examining all straps and metal fittings.

Step 2: Cylinder Valve Assembly Leak Test

The cylinder valve assembly leak test checks for leaks in the cylinder valve assembly by immersing the top of the cylinder in water.

There are two parts to this in order for the entire cylinder valve assembly to be tested for leaks. The first part of the test checks the:

1. Main cylinder valve stem;
2. Neck of the cylinder; and
3. Opening of the bypass valve.

The second part of the test checks the:

1. Bypass valve stem; and
2. Opening of the main cylinder valve.

The procedure for the entire test is as follows:

Note: You will need a tub or container full of water to perform this test.

1. Remove the cylinder from the apparatus, if not already removed.

Note: If you need to review the procedure for removing the cylinder, refer back to the "Parts" section, under the heading "Oxygen Cylinder."

2. Cap the main cylinder valve opening with the cylinder cap provided for this purpose. Open the main cylinder valve all the way.

3. Immerse the valve assembly and cylinder neck in water and check for air bubbles coming out of the submerged parts. No bubbles should appear from around the main cylinder valve stem, neck of the cylinder, or opening of the bypass valve.

   If there are leaks in these parts, they should be properly repaired before use.

4. Close the main cylinder valve.

5. Take the cylinder cap off the main valve and put the smaller cap provided on the bypass valve opening.

6. Open the bypass valve and immerse the valve assembly in water to check for air leaks around the bypass valve stem and the main cylinder valve opening.

   If there are leaks in these parts, they should be properly repaired before use.

7. Close the bypass valve and remove the cap from the bypass valve opening.

Step 3: Removing Moisture From Cylinder

The next step in the testing procedure is to remove moisture from the oxygen cylinder. This involves quickly opening and closing the main cylinder valve to allow small amounts of moisture to escape from the cylinder or valve assembly. When you do this, hold the cylinder away from you with the neck downward to prevent any dust or moisture from blowing into your eyes.

You cannot remove large amounts of impurities by a quick opening and closing of the valve. A cylinder with large amounts of moisture, sediment, or rust will have to be sent back to the manufacturer for repairs and retesting.

Step 4: Filling the Regenerator

If the apparatus is going to be worn right after you finish testing it, the next step is to fill the regenerator with Cardoxide. If you are performing a routine test on the apparatus, you do not have to put Cardoxide into the regenerator.

Before filling the regenerator make sure it is clean. Then pour in the Cardoxide to completely fill the regenerator and replace the regenerator cap.

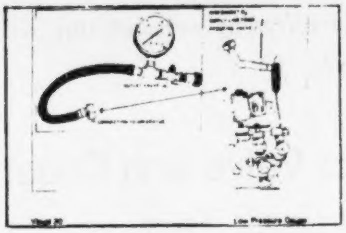
Step 5: Inserting the Oxygen Cylinder

Now you can insert the oxygen cylinder. Before connecting the cylinder to the high-pressure fitting of the reducing valve, check the high-pressure connection to make sure the gasket and copper screen are in good condition and in place.

Then fasten the bypass line firmly to the outlet of the bypass valve and tighten the metal strap around the center of the cylinder so it firmly supports the cylinder in the apparatus.

Step 6: Connecting Low-Pressure Test Gauge

Visual: Refer back to "Visual 20" for an illustration showing where to attach the low-pressure gauge as you discuss it below.



At this point, you attach the low-pressure test gauge because you will be monitoring the apparatus's oxygen supply system, particularly the reducing valve assembly.

To attach the low-pressure test gauge, disconnect the oxygen supply line from the outlet of the reducing valve and insert the test gauge between the outlet of the reducing valve and the oxygen supply line.

Step 7: Reducing Valve Pressure Test

The first of the tests to monitor the McCaa's oxygen supply system is the reducing valve pressure test. This test checks the shutoff pressure of the reducing valve to make sure that the reducing valve closes when the pressure within the bellows reaches 3 to 4½ PSI.

Note: *In the next step it is very important to leave the outlet of the test gauge open until you have opened the main cylinder valve.* This will eliminate the possibility of blowing the gauge hose or damaging the gauge if the reducing valve malfunctions.

To do this test, first open the main cylinder valve, and then close the outlet valve of the test gauge. Read the pressure on the gauge. The reading should be steady and between 3 and 4½ PSI.

If the pressure is lower than 3 PSI or higher than 4½ PSI, the reducing valve must be returned to the manufacturer for repairs.

After the initial reading of 3 to 4½ PSI, watch the gauge needle for 30 seconds. If the reading increases, this can indicate a shutoff valve leak.

Step 8: Reducing Valve and Chest Pressure Gauge Leak Test

In the leak test of the reducing valve and chest pressure gauge, you will be checking to see if there are leaks in the parts between the main cylinder valve and the outlet of the test gauge valve.

So, with the test gauge outlet valve closed and the chest gauge valve open, read the high-pressure gauge and the low-pressure test gauge.

Then close the main cylinder valve and observe both pressure gauges. The readings should not change.

If leaks are present between the main cylinder valve and the outlet of the test gauge valve (reducing valve, chest gauge, gauge line, and gauge valve), both the gauges will drop toward zero.

If the gauges drop, try to locate the leaks by brushing a leak-detection solution, such as soapsuds, over the parts and connections that are under pressure. Repair all leaks and replace defective parts as necessary. Remember, the reducing valve must be returned to the manufacturer for repairs.

Step 9: Oxygen Flow Test of Reducing Valve

This next test measures the oxygen flow pressure of the reducing valve to make sure that the oxygen flow is at least ½ PSI.

To do this test, first open the main cylinder valve. Then open the test gauge valve and press down on the bumper plate of the breathing bag to open the admission valve. This permits oxygen to flow through the reducing valve and on up through the admission valve.

Observe the test gauge. It should read at least ½ PSI. If the oxygen flow pressure is less than ½ PSI, you will have to have the reducing valve replaced by the manufacturer.

If the flow pressure is okay, close the admission valve by raising the bumper plate of the breathing bag.

Step 10: Safety Valve and Whistle Test

To test the safety valve and whistle, you are going to simulate a malfunction of the reducing valve by squeezing the bellows of the reducing valve so that oxygen is forced out of the reducing valve at a higher-than-normal pressure.

With the test gauge still attached and the main cylinder valve open, gently press the bellows straight in and observe the low-pressure test gauge.

Note: This test should always be done carefully, since squeezing the rim of the bellows too hard or on an edge can ruin the reducing valve.

The safety valve and whistle should operate between 7 to 9 PSI. If not, the safety valve will have to be replaced by the manufacturer.

If the safety valve is okay, close the main cylinder valve and open the admission valve to allow the trapped oxygen to escape.

Step 11: Removing Test Gauge

Now you can remove the test gauge and reconnect the oxygen supply line to the reducing valve outlet. Before you attach the oxygen line, check the gasket in it to make sure it is in place and in good condition.

Step 12: Facepiece and Flexible Hoses Test

Mouthpiece note: Refer to the *Appendix* for the lecture, "Testing the Mouthpiece and Flexible Hoses."

The procedure for testing the facepiece and its valves, and flexible hoses is as follows:

Note: The hoses should be attached to the facepiece.

1. First, look over the facepiece and hoses to make sure they are in good condition. Check the valve housing, lens and frame, and breathing hoses for tears, cracks, and other signs of wear. Bend the hoses and rubber parts of the facepiece back and forth several times to make sure they're flexible. Check the hose clamps for tightness and make sure the hose gaskets are in place and in good condition. Replace the gaskets if they are in bad condition. And don't forget to examine the rubber straps of the head harness.

2. Take apart the speaking diaphragm and check to see that the parts are in good condition. Then put the speaking diaphragm back into the facepiece, being careful to reassemble it properly.

Visual: Refer to either "Visual 13" (Ultravue) or "Visual 15" (All-Vision) for a guide to how the speaking diaphragm fits together.

3. Now put on the facepiece and adjust it so that you have a good face-to-facepiece seal.

4. The first things to check on the facepiece are the inhalation and exhalation valves to make sure that they open and close as you breathe. So quickly inhale and exhale through the facepiece and listen for the valves to open and close.

Note: On the Ultravue facepiece, the valves are rubber and they produce a soft flapping noise as they close.

On the All-Vision facepiece, the valves are mica-discs and they produce a clicking noise as they close.

5. Now operate the pressure relief valve plunger several times to make sure that it opens and closes freely.

6. Next, test the inhalation valve to make sure that it functions as a one-way valve to allow air into the facepiece and not out of it. During this test you will also be testing the pressure relief valve to make sure that it does not allow air to escape through it when closed.

   To do this test: Cover the exhalation hose opening (hose on right when wearing) with your hand and exhale slowly and forcibly into the facepiece. Since you've blocked the air's normal route of escape (through the exhalation hose), pressure should build up within the facepiece before air escapes around the edges of the facepiece.

   If air escapes only around the edges of the facepiece, it means the inhalation valve and pressure relief valve are operating properly to keep air from being exhaled through the valves.

   If air leaks out through the inhalation valve, the inhalation valve is not functioning as a one-way valve and will have to be replaced. If air escapes through the closed pressure relief valve, it will also have to be replaced.

7. Now, to test the pressure relief valve for airtightness, squeeze the exhalation hose shut and exhale into the facepiece until pressure builds up in the facepiece. Then quickly open and close the pressure relief valve. When the valve is closed, try to exhale to the outside (with the exhalation hose still squeezed).

   If the valve closes properly, no air should escape through it. If the relief valve doesn't seal properly, it will have to be replaced.

8. Next, test the exhalation valve and pressure relief valve to make sure they don't allow air into the facepiece.

Note: On the All-Vision facepiece, when you check the pressure relief valve for inward leakage, you are actually testing the relief valve check valve to make sure it works properly.

On the Ultravue facepiece you are actually testing to make sure that the pressure relief valve is a one-way valve.

Cover the inhalation hose opening (hose on the left) with your hand and open the pressure relief valve. Inhale deeply. This should create a vacuum in the mask causing it to collapse against your face.

No air should enter through the exhalation valve indicating that it is functioning properly as a one-way valve to keep air from entering the facepiece.

Also, no air should enter through the pressure relief valve indicating that it is operating properly to keep air from entering the facepiece when it is open.

This test also checks for leakage in the speaking diaphragm, facepiece, and inhalation hose. Air leaking into the facepiece at any one of these places will keep the mask from collapsing against your face.

9. Now check the exhalation hose. (You checked the inhalation hose as part of the previous test.) Take off the facepiece and blow forcefully into the end of the exhalation hose (hose on the right when wearing).

You should meet resistance as soon as air has filled the hose. Air should not escape from the hose indicating that the hose is free of leaks and air does not pass between the exhalation valve itself and the wall of the valve housing. Replace the hose if necessary.

10. Remove the facepiece.

Valve Testing in Water

Note: Valve testing in water is an alternate method of checking for leaks in the inhalation and exhalation valves (and for the All-Vision facepiece: the pressure relief check valve). Also, if you have found a leak in the previous test, testing in water can be used to determine if the leak is in the valve itself.

The procedure for testing the facepiece assembly valves for leaks in water is as follows:

Note: You will need a tub or container full of water to perform this test.

To test the inhalation valve: Squeeze the exhalation hose (on the right when wearing) shut and put the end of the inhalation hose in water. Then exhale forcibly into the facepiece to see if air can be exhaled through the inhalation valve.

If you see air bubbles coming out of the inhalation hose, it could mean that the inhalation valve is leaking or that air is passing between the inhalation valve itself and the wall of the valve housing. If the valve is leaking it will have to be replaced.

To test the exhalation valve: Immerse the facepiece in water and exhale forcibly into the exhalation hose. You are testing to see if air enters the facepiece through the exhalation valve which is only supposed to let air out of the facepiece.

If you see air bubbles coming from the facepiece, the exhalation valve is either leaking or air is passing between the valve itself and the wall of the valve housing. If the valve is leaking, it will have to be replaced.

Note: The next step is for the All-Vision facepiece only. Omit it if the team uses the Ultravue facepiece.

To test the pressure relief check valve on the All-Vision facepiece for inward leakage: Remove the pressure relief valve and the relief valve spring and immerse the facepiece in water. Then blow into the valve housing through the relief valve connection.

If air bubbles come from the facepiece, the check valve leaks and will have to be replaced.

When reassembling the relief valve, always make sure the spring is correctly placed. Incorrect placement will foul the operation of the check valve. Also make sure that the spring and valve gasket are in good condition.

Step 13: Assembling the Apparatus

Assemble the apparatus when you're finished testing the facepiece and hoses.

Connect the rigid hoses to the apparatus making sure that you first check the gaskets in the connections to see if they are in place and in good condition. Remember, the longer hose is the exhalation hose and it connects to the regenerator.

When connecting the facepiece and flexible breathing hoses to the rigid hoses, make sure that the rubber gaskets are okay and that you connect the hoses properly. Remember, the exhalation side of the facepiece is on your right.

Step 14: Assembled Apparatus Leak Test

The final step in the testing procedure is to check the entire assembled apparatus for leaks. There are four parts to this step of the testing procedure:

1. **Leak testing high- and medium-pressure side;**
2. **Checking admission valve;**
3. **Checking safety valve; and**
4. **Leak testing low-pressure side.**

Leak Testing High- and Medium-Pressure Side

You begin the procedure by testing the high- and medium-pressure side of the apparatus (or everything from the oxygen cylinder to the admission valve).

1. **Close the admission valve by raising the breathing bag and open the main cylinder valve.**
2. **With the gauge valve open, read the pressure gauge and then close the main cylinder valve.**

3. Observe the gauge. The needle should remain stationary indicating that the high- and medium-pressure parts and connections from the oxygen cylinder to the admission valve are airtight (the cylinder and valve assembly, the reducing valve, gauge valve, gauge line and gauge).

If you have a leak somewhere and you need to locate it, brush a leak-finding solution over the parts. Repair all leaks and replace any defective parts that you find during this test.

Checking Admission Valve

The admission valve must be checked to make sure that it opens and closes freely and that when closed, it seals completely. The procedure for this test is as follows:

Note: This test starts where the previous test left off—with oxygen still in the apparatus (indicated on the gauge) and the main cylinder valve closed.

1. Open and close the admission valve quickly.
2. After the admission valve is closed, watch the pressure gauge needle to see if it moves toward zero. If it falls, something is wrong with the admission valve. It is possible that dirt has gotten lodged under the valve seat causing it to seal improperly. To try to fix this, open and close the admission valve several times to blow out the dirt. If the valve continues to leak, it will have to be replaced.

Checking Safety Valve

The safety valve was checked in a previous test, but it should be tested again now to further assure you that it functions properly. This test is shorter than the original test. Here you will only be testing to see that the safety whistle sounds when you squeeze the bellows.

So, gently squeeze the bellows at its center and listen for the whistle to sound. If the whistle does not sound, the safety valve will have to be tested further to determine what the problem is or it will have to be replaced.

Note: Refer to "Step 10" of the testing procedure, "Safety Valve and Whistle Test" for further testing of the safety valve.

Leak Testing Low-Pressure Side

You finish the test by checking for leaks in the low-pressure side of the apparatus (breathing bag, cooler, regenerator, rigid breathing hoses, bypass line, and connections).

1. Squeeze the flexible breathing hoses shut with one hand, and with your other hand carefully open the bypass valve momentarily to slowly inflate the breathing bag. It is very important not to overfill the bag because it could rupture. Be sure to quickly close the bypass valve as soon as the bag is full.

Note: The team should be aware that this filling procedure also tests the bypass valve to see that it works to quickly provide oxygen to the breathing bag.

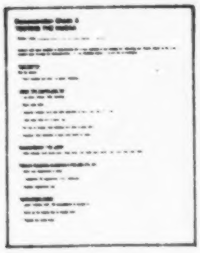
2. Now press firmly on the breathing bag to compress the air in it and create pressure within the low-pressure parts.

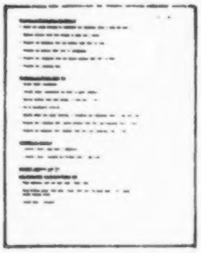
3. If the bag remains fully inflated, it means the low-pressure parts are airtight.

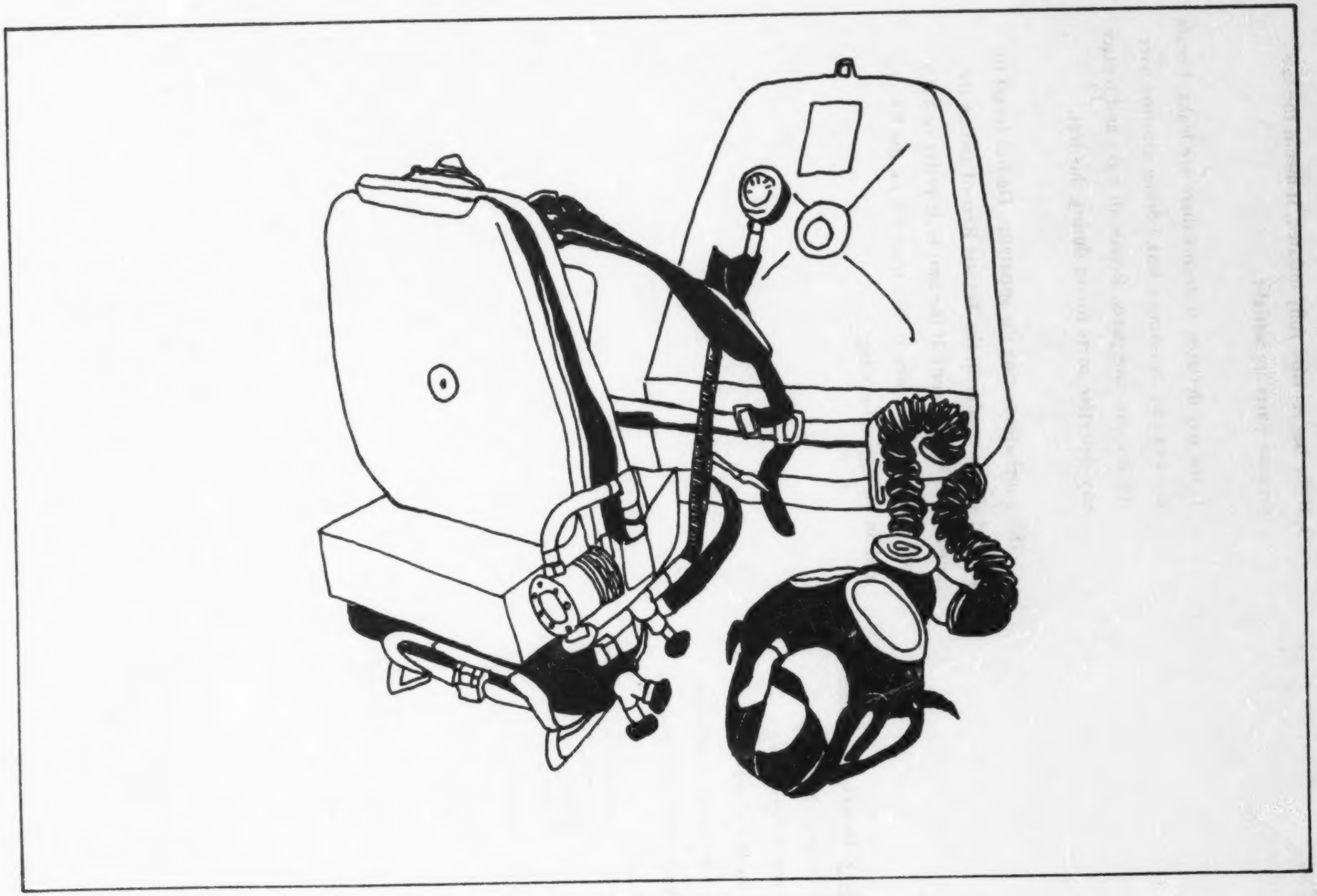
   If the bag deflates, it means there are leaks. Locate the leaks by brushing a leak-finding solution over the low-pressure parts. Repair all leaks and replace any defective parts found during this test.

This concludes testing the apparatus. Do not forget to record all test results on the Testing Record and on the apparatus's tag (if used). If the unit is defective or has a part removed, make sure to also note this on the Record and on the apparatus's tag.

Demonstration check: Have each team member perform all the steps of the testing procedure. Use copies of *Demonstration Check 3–Testing the McCaa,* provided at the back of this module, to check each team member's performance. Review the results with each team member.

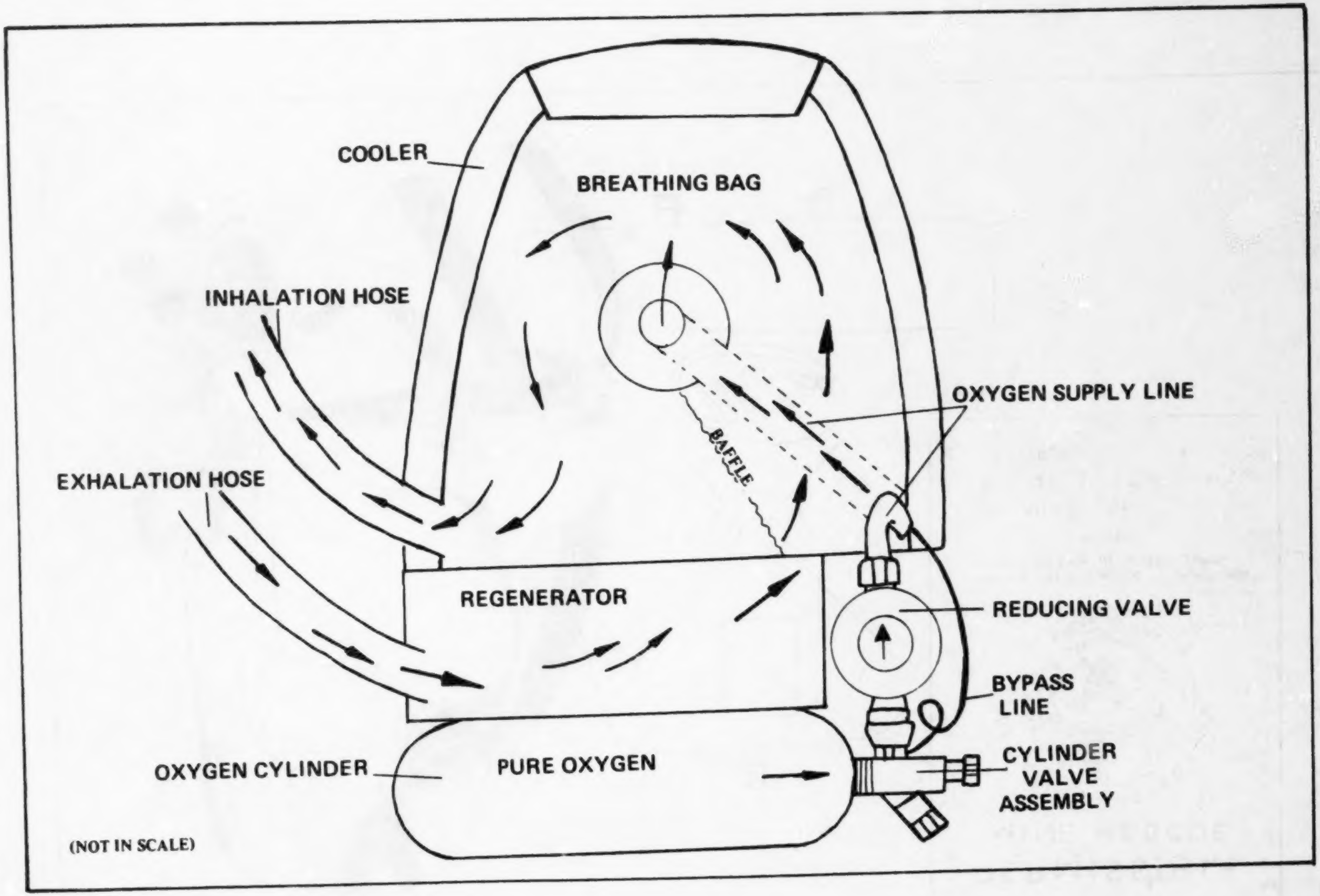




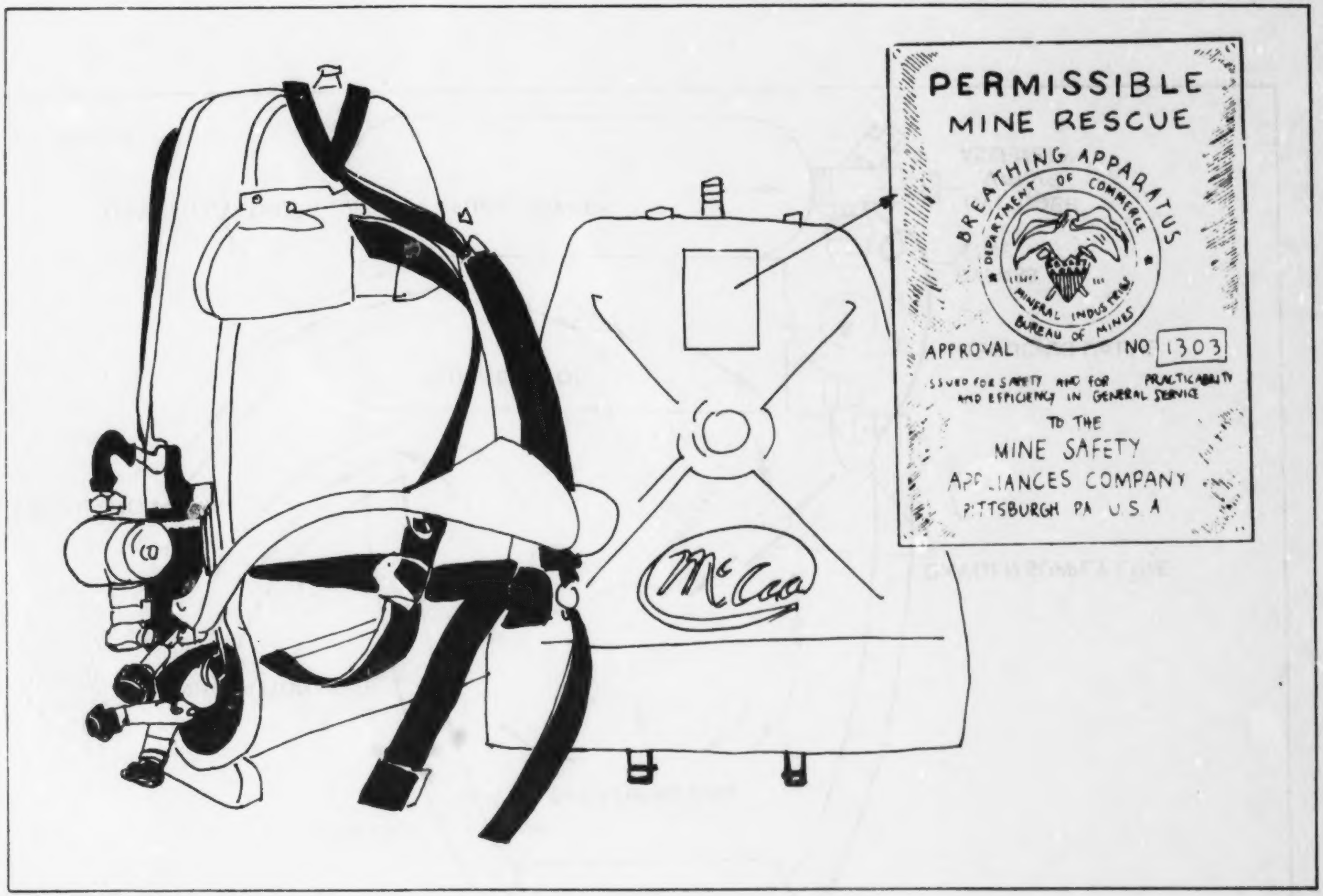


Visual 1

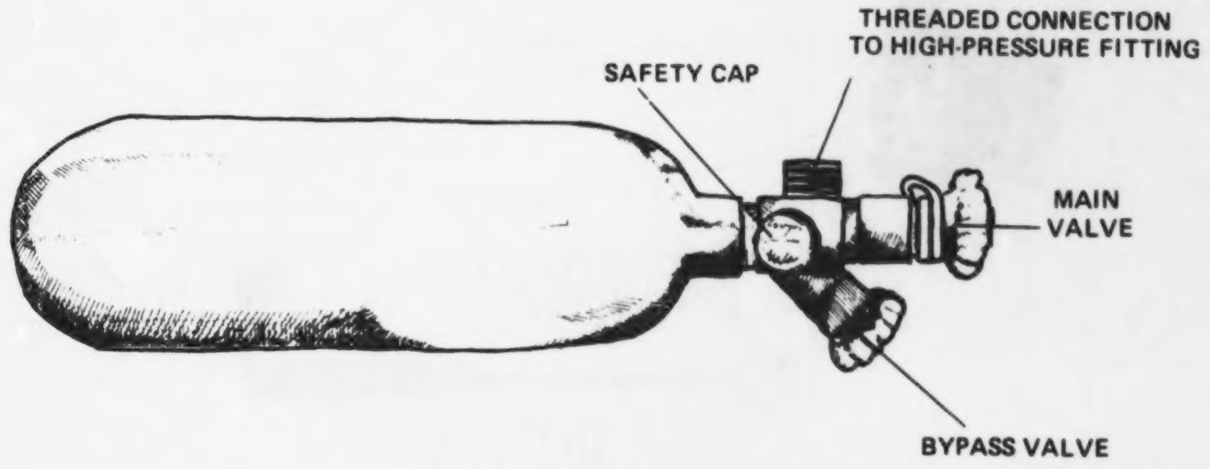
McCaa Apparatus


COOLER
BREATHING BAG
INHALATION HOSE
OXYGEN SUPPLY LINE
BAFFLE
EXHALATION HOSE
REGENERATOR
REDUCING VALVE
BYPASS LINE
OXYGEN CYLINDER
PURE OXYGEN
CYLINDER VALVE ASSEMBLY
(NOT IN SCALE)

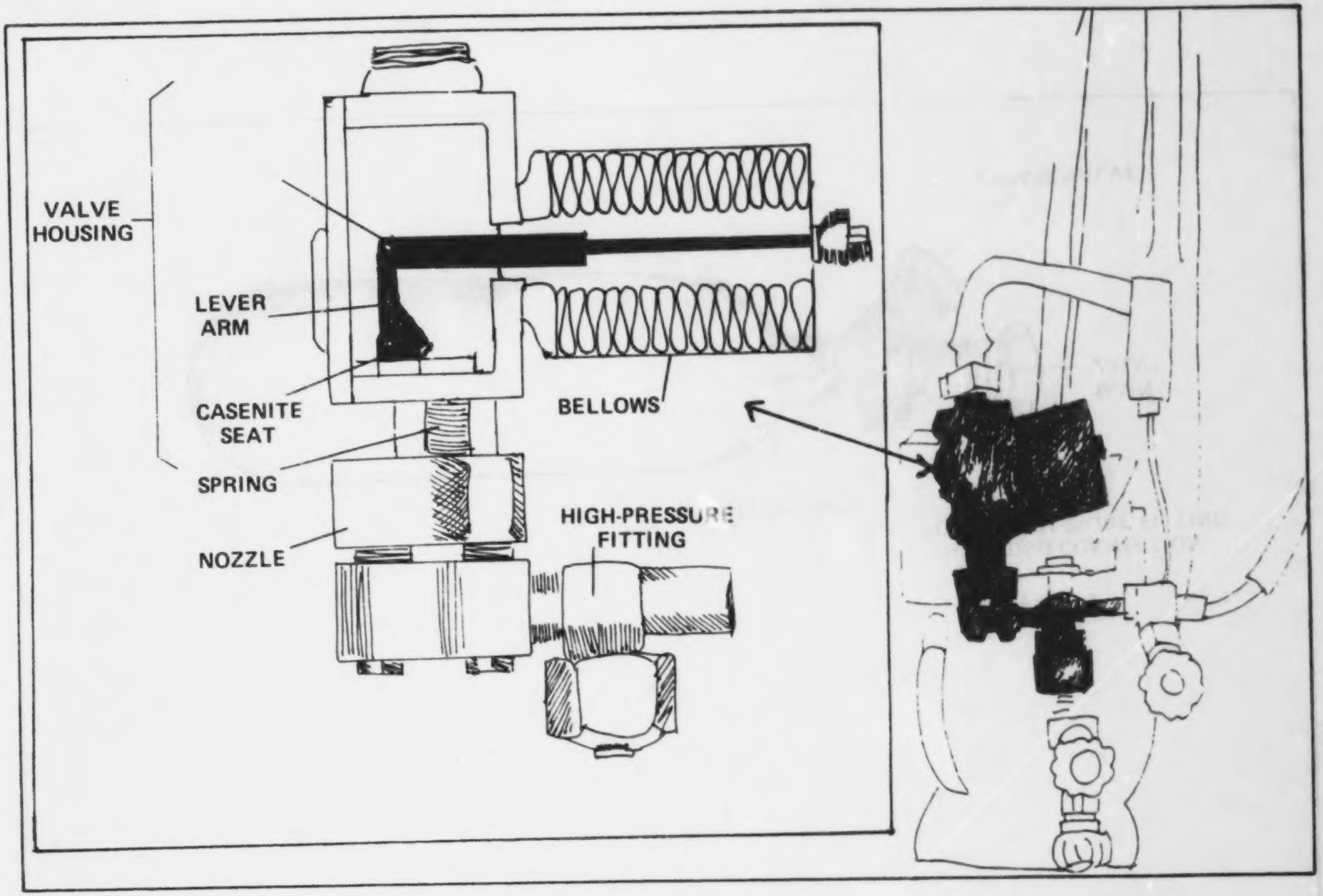
Visual 2 Airflow Design of McCaa


PERMISSIBLE
MINE RESCUE
BREATHING APPARATUS
DEPARTMENT OF COMMERCE
MINERAL INDUSTRIES
BUREAU OF MINES
APPROVAL NO. 1303
ISSUED FOR SAFETY AND FOR PRACTICABILITY AND EFFICIENCY IN GENERAL SERVICE
TO THE
MINE SAFETY
APPLIANCES COMPANY
PITTSBURGH PA U.S.A
McCaa

Visual 3 Protective Cover and Wearing Harness

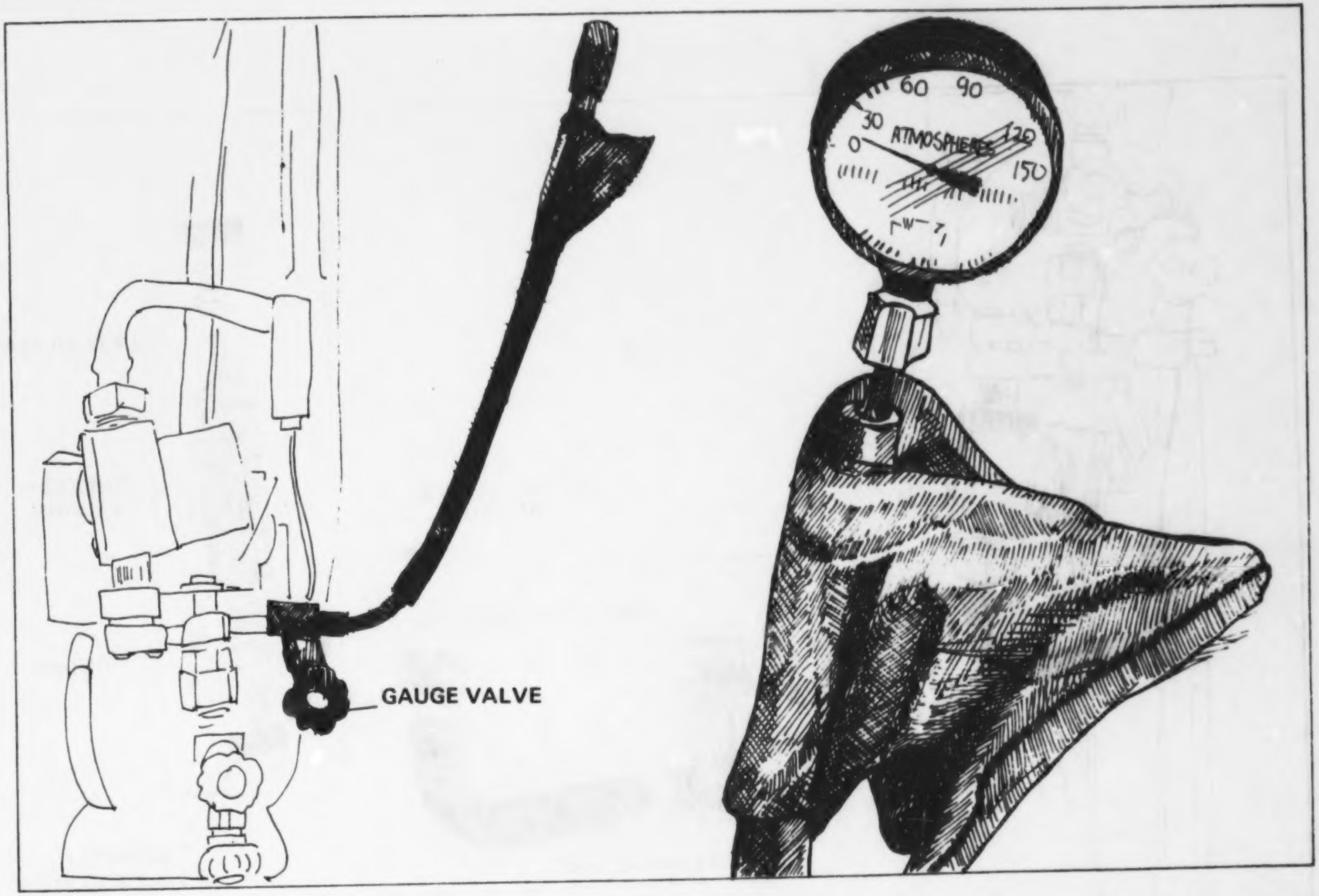

THREADED CONNECTION
TO HIGH-PRESSURE FITTING
SAFETY CAP
MAIN
VALVE
BYPASS VALVE

Visual 4 Oxygen Cylinder and Valve Assembly


VALVE HOUSING
LEVER ARM
CASENITE SEAT
SPRING
NOZZLE
BELLOWS
HIGH-PRESSURE FITTING

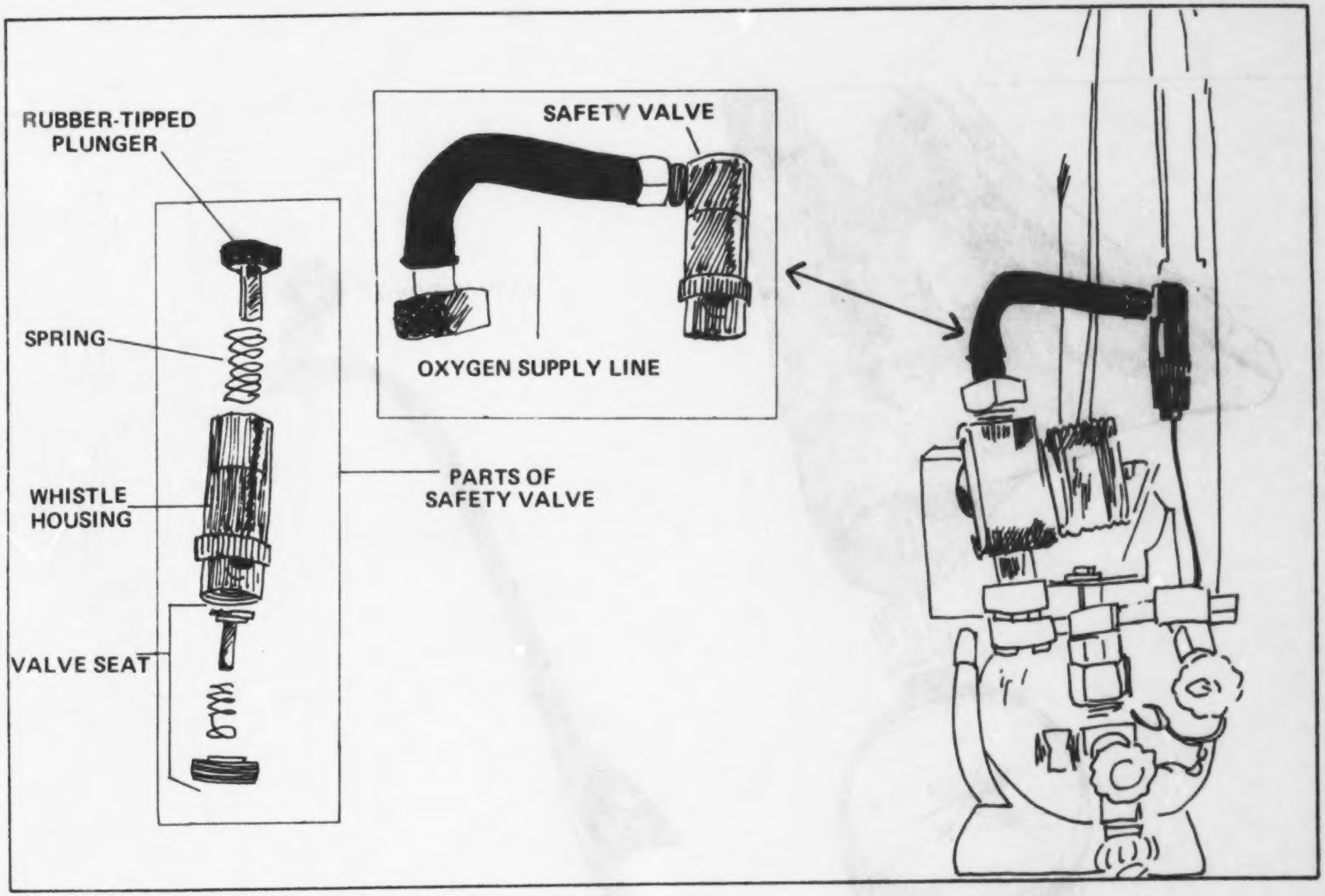
Visual 5

Reducing Valve Assembly

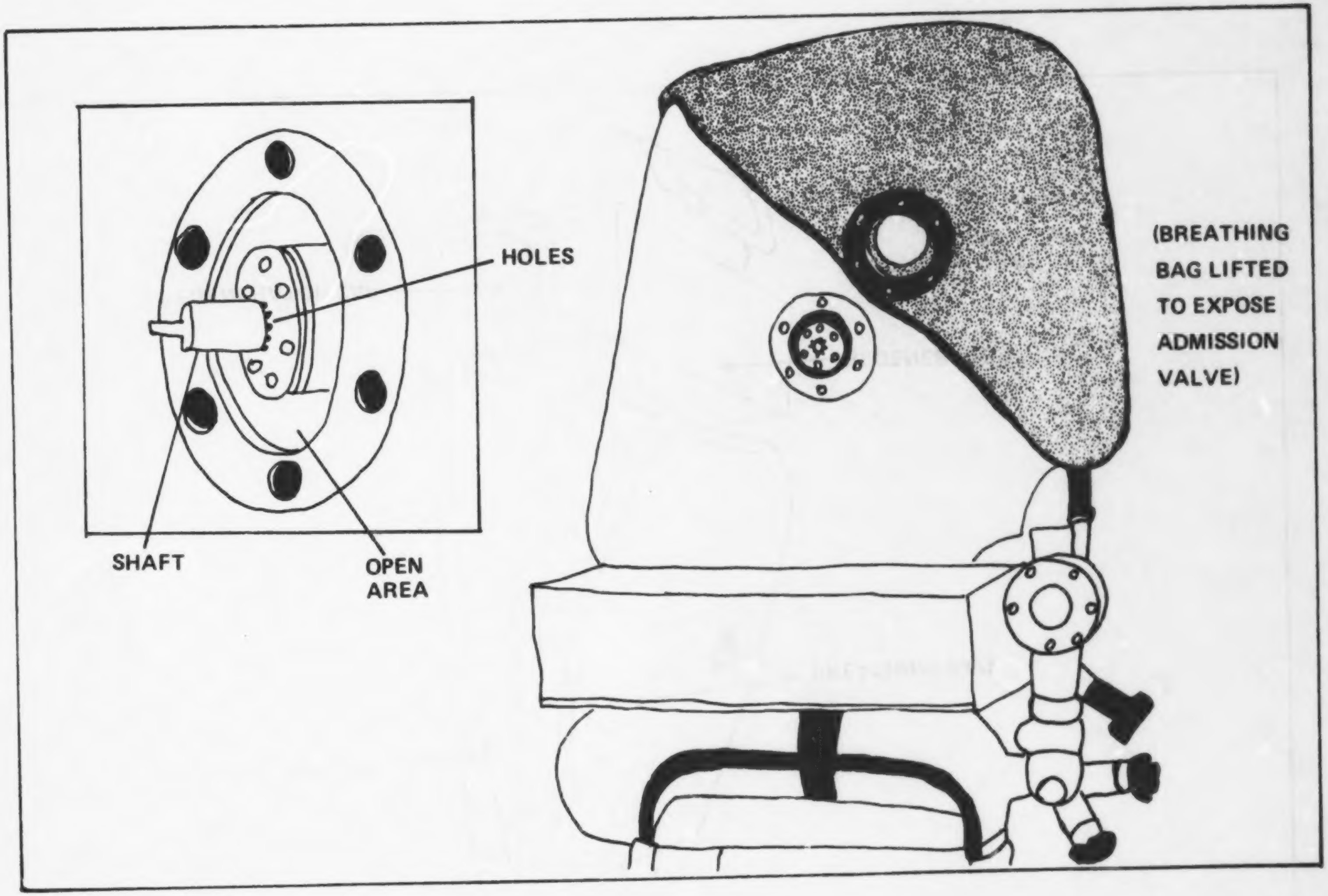

GAUGE VALVE
0
30
60
90
120
150
ATMOSPHERES

Visual 6

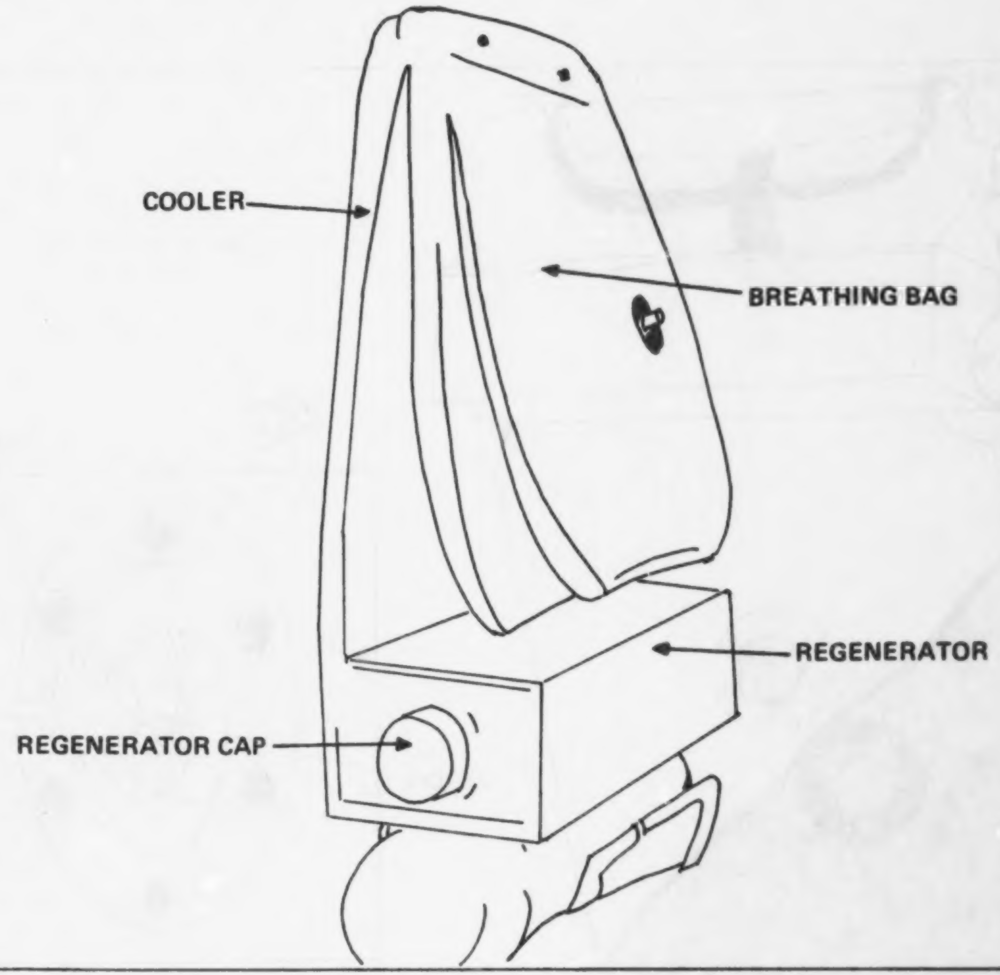
Pressure Gauge and Gauge Valve


RUBBER-TIPPED PLUNGER
SPRING
WHISTLE HOUSING
VALVE SEAT
SAFETY VALVE
OXYGEN SUPPLY LINE
PARTS OF SAFETY VALVE

Visual 7 Oxygen Supply Line and Safety Valve

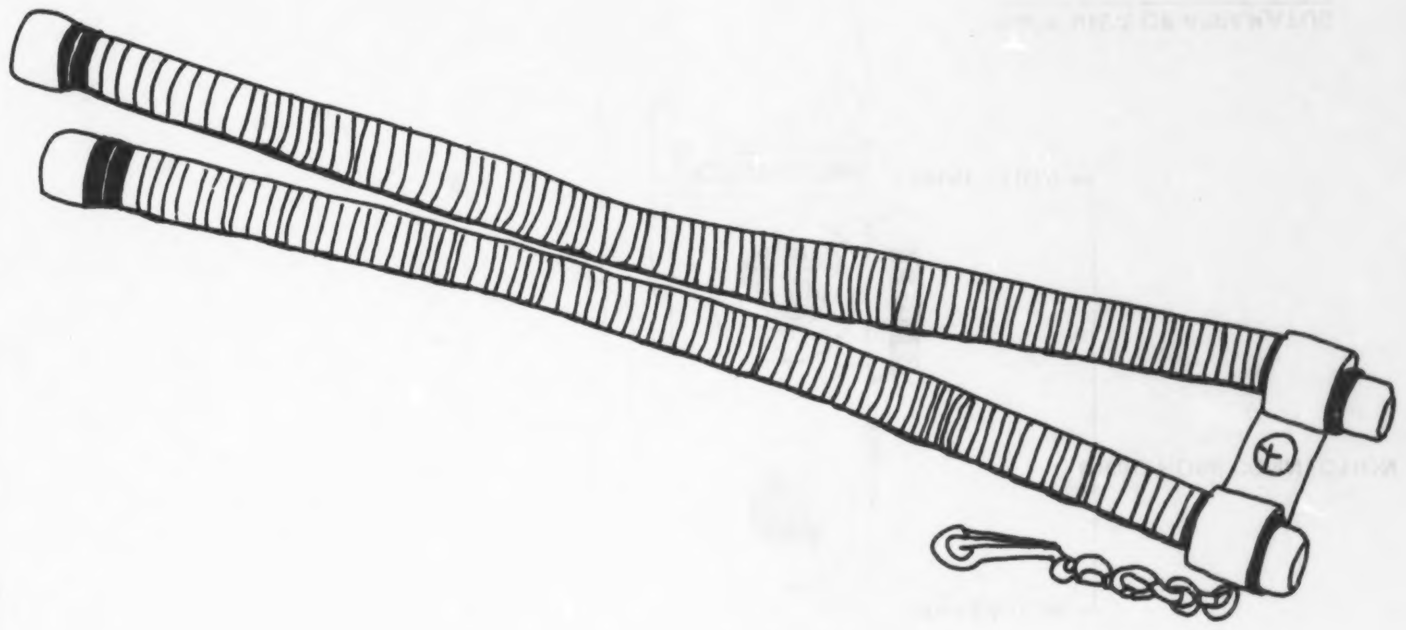

HOLES
SHAFT
OPEN AREA
(BREATHING BAG LIFTED TO EXPOSE ADMISSION VALVE)

Visual 8 Admission Valve



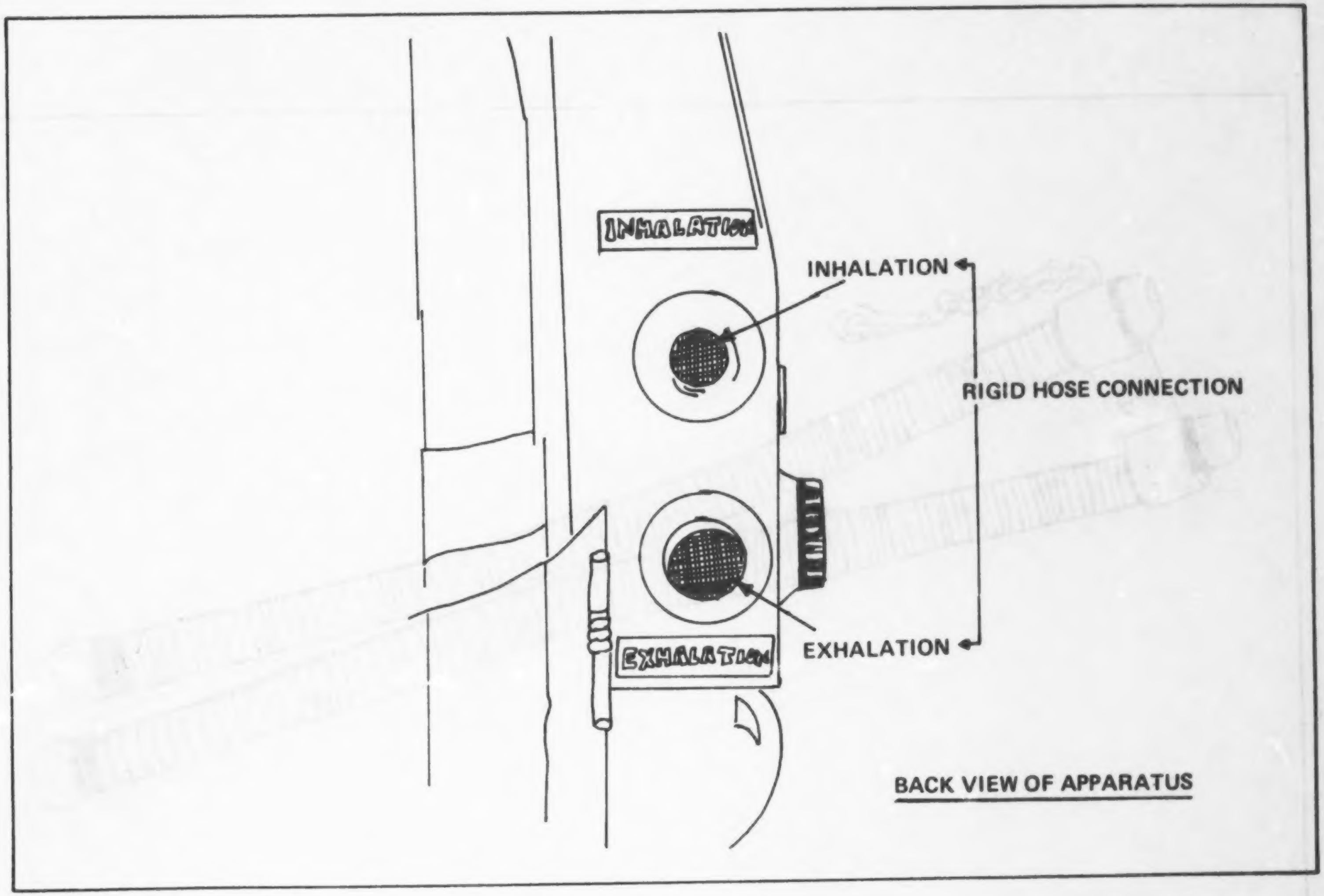
COOLER
BREATHING BAG
REGENERATOR
REGENERATOR CAP

Visual 9 Breathing Bag , Cooler , and Regenerator



Visual 10

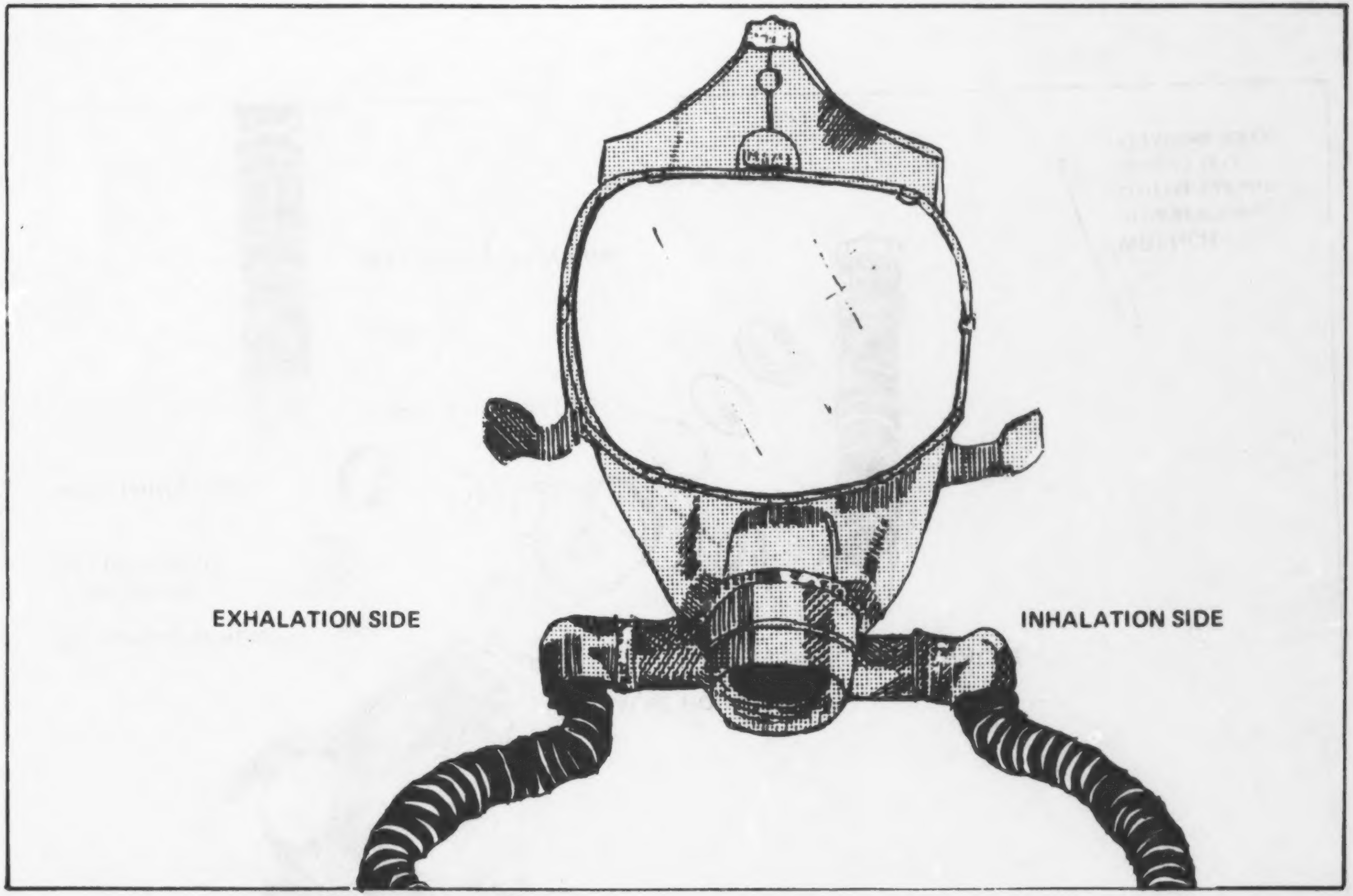
Rigid Breathing Hoses


INHALATION
INHALATION
RIGID HOSE CONNECTION
EXHALATION
EXHALATION

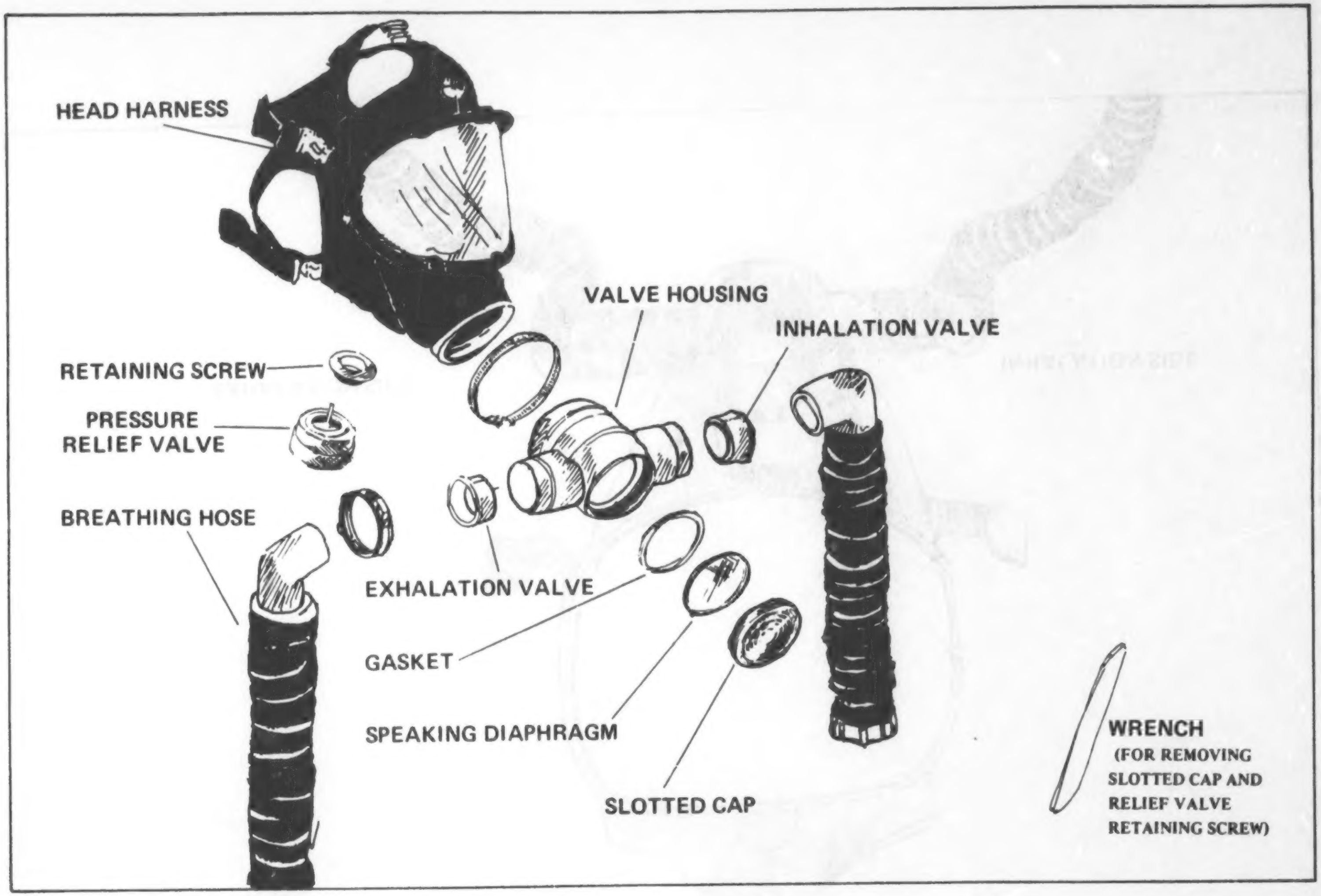
BACK VIEW OF APPARATUS

Visual 11

Rigid Hose Connections

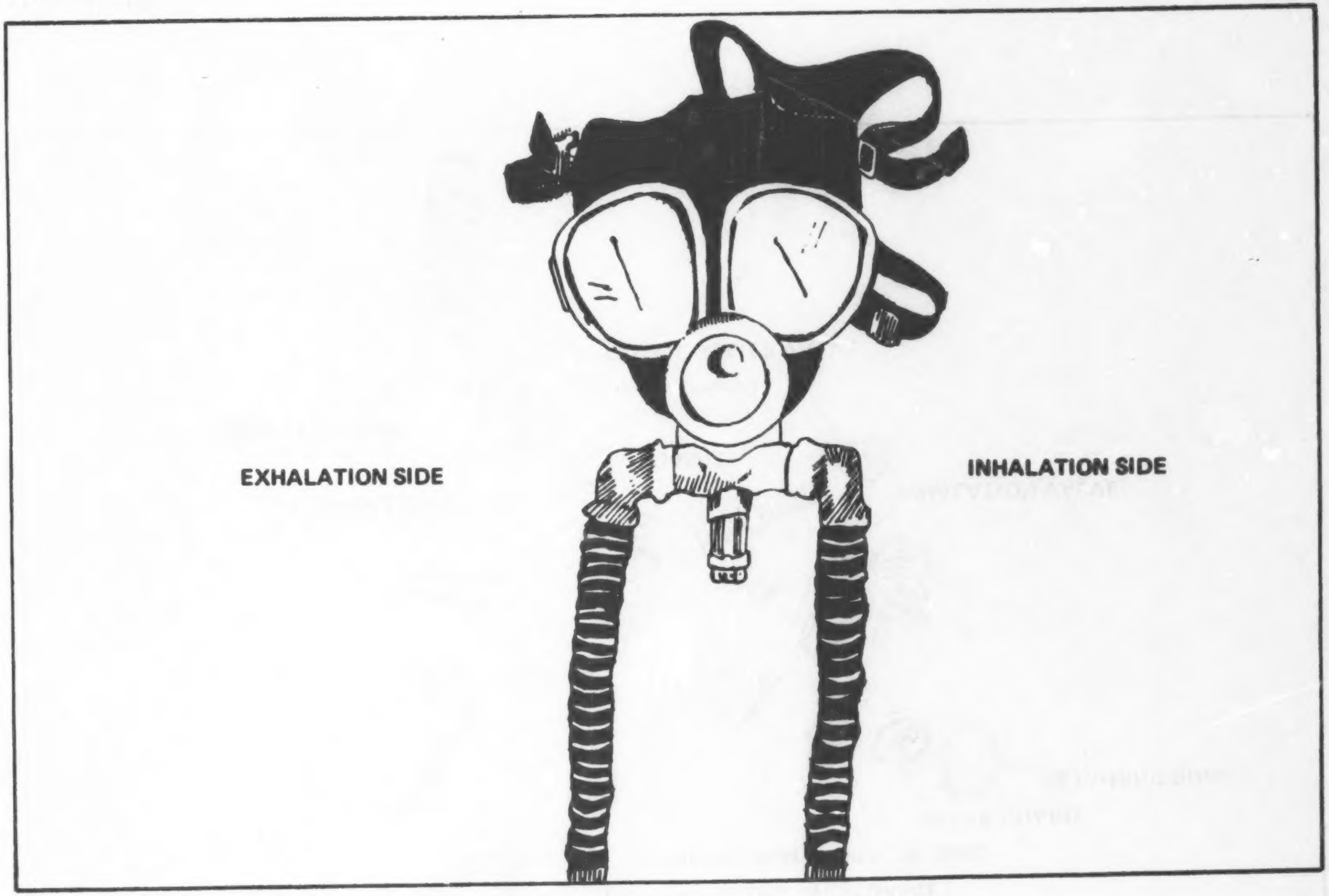

EXHALATION SIDE
INHALATION SIDE

Visual 12 Ultravue Facepiece


HEAD HARNESS
VALVE HOUSING
INHALATION VALVE
RETAINING SCREW
PRESSURE RELIEF VALVE
BREATHING HOSE
EXHALATION VALVE
GASKET
SPEAKING DIAPHRAGM
SLOTTED CAP
WRENCH
(FOR REMOVING SLOTTED CAP AND RELIEF VALVE RETAINING SCREW)

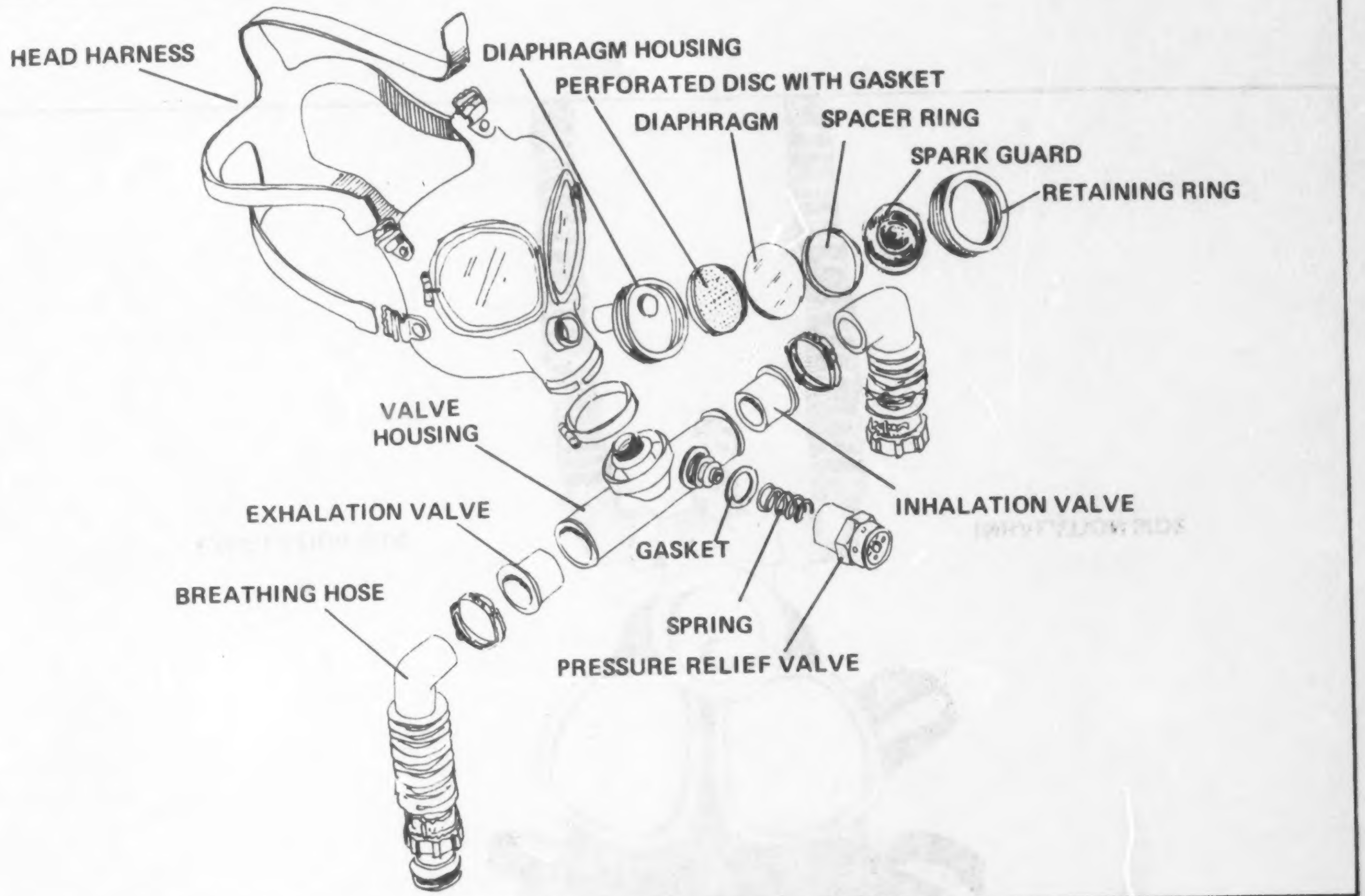
Visual 13

Ultravue Facepiece


EXHALATION SIDE
INHALATION SIDE

Visual 14

All-Vision Facepiece


HEAD HARNESS
DIAPHRAGM HOUSING
PERFORATED DISC WITH GASKET
DIAPHRAGM
SPACER RING
SPARK GUARD
RETAINING RING
VALVE HOUSING
INHALATION VALVE
EXHALATION VALVE
GASKET
BREATHING HOSE
SPRING
PRESSURE RELIEF VALVE

Visual 15

All–Vision Facepiece

Visual 16
Sample Testing Record

Test	For each test below, record the date of testing and initials of the tester.				
Visual Inspection					
Cylinder Valve Assembly Leak Test					
Removing Moisture From Cylinder					
Reducing Valve Pressure Test					
Reducing Valve and Pressure Gauge Leak Test					
Oxygen Flow Test of Reducing Valve					
Safety Valve and Whistle Test					
Facepiece and Flexible Hoses Test					
Assembled Apparatus Leak Test (1) High- and Medium-Pressure Side					
(2) Admission Valve					
(3) Safety Valve					
(4) Low-Pressure Side					
Cylinder Pressure at End of Test					

Visual 17
Sample Maintenance Record

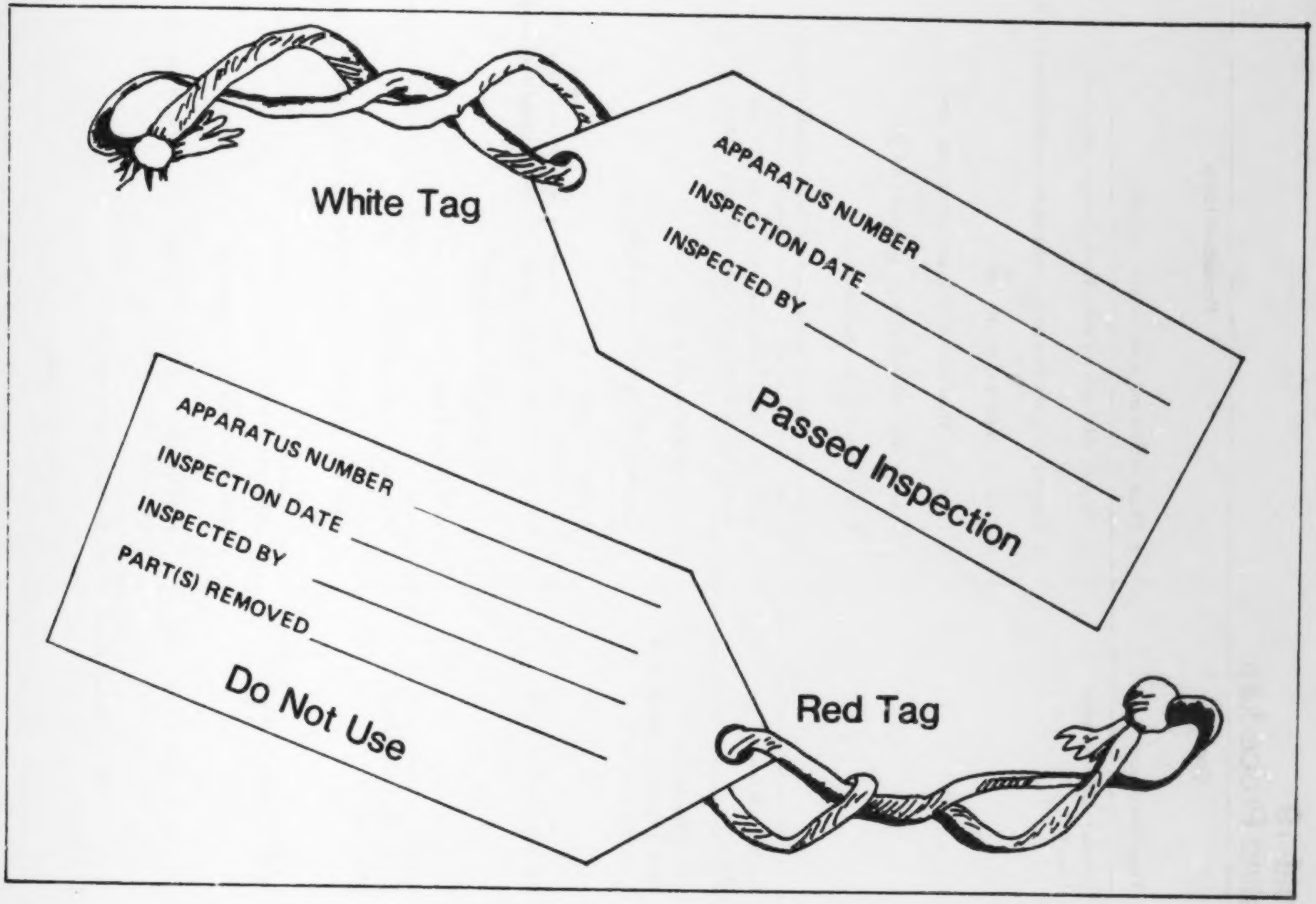
Apparatus Type: ____________________ **Serial #** ____________________

Apparatus # ____________________

Purchase date ____________________

# Hours Used	Total Hours Used	Date Inspected	Parts Repaired or Replaced	Comments	Inspected By

READEX FICHE


White Tag
APPARATUS NUMBER
INSPECTION DATE
INSPECTED BY
Passed Inspection
APPARATUS NUMBER
INSPECTION DATE
INSPECTED BY
PART(S) REMOVED
Do Not Use
Red Tag

Visual 18

Sample Tags

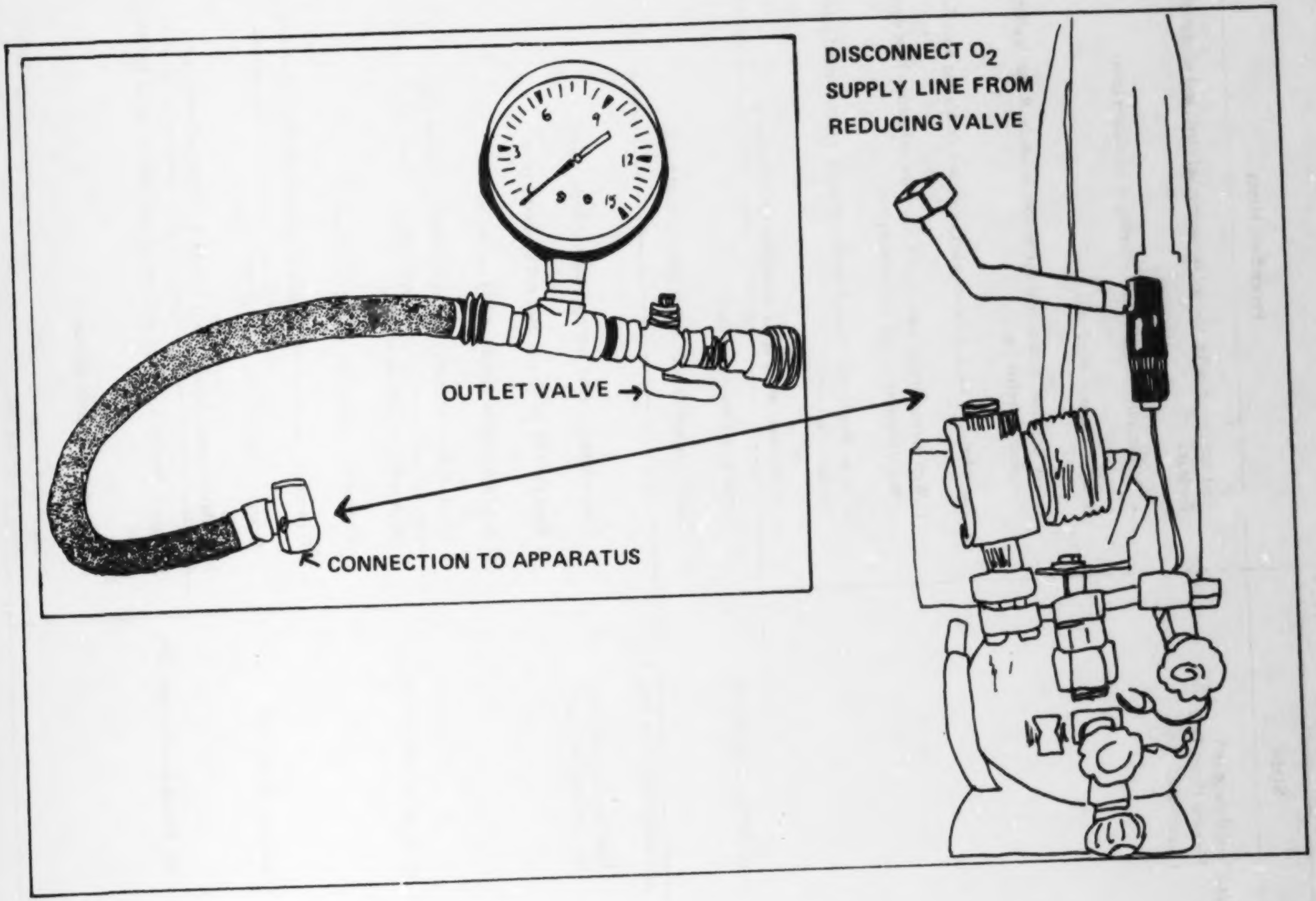
Visual 19
Testing Procedure

Steps	Procedure Hints
1. Visual Inspection	1. Check harness and cover for good condition.
2. Cylinder Valve Assembly Leak Test	1. Cap main valve opening with cylinder cap and open main valve. 2. Immerse valve assembly and cylinder neck in water to check for leaks. 3. Close main valve and remove cap. 4. Put cap on bypass valve opening and open bypass valve. 5. Immerse valve assembly in water to check for leaks. 6. Close bypass valve and remove cap. 7. If there are leaks during the test, have them properly repaired.
3. Removing Moisture From Cylinder	1. Hold cylinder away from you, with cylinder neck downward, and quickly open and close main valve to remove small amounts of moisture.
4. Filling Regenerator (only if apparatus is going to be worn right after test)	1. Make sure regenerator is clean. 2. Completely fill regenerator with Cardoxide. 3. Replace regenerator cap.
5. Inserting Oxygen Cylinder	1. Insert a "+" rated oxygen cylinder with 165 atmospheres of oxygen in it. 2. Hook up bypass line to bypass valve. 3. Tighten metal strap.
6. Connecting Low-Pressure Test Gauge	1. Disconnect oxygen supply line. 2. Insert test gauge between outlet of reducing valve and oxygen supply line.
7. Reducing Valve Pressure Test	1. Open main cylinder valve. 2. Close outlet valve of test gauge and read test gauge. 3. Reading should be steady and between 3 and 4½ PSI. If not, reducing valve must be replaced.
8. Reducing Valve and Pressure Gauge Leak Test	1. Test gauge outlet valve closed. 2. Chest gauge valve open. 3. Read both gauges, close main cylinder valve and continue to read gauges.

Steps	Procedure Hints
8. Reducing Valve and Pressure Gauge Leak Test (Continued)	4. Readings should not change if there are no leaks. 5. Readings will drop if there are leaks in reducing valve, chest gauge, gauge line, or gauge valve. 6. If there are leaks, brush on leak-finding solution. If necessary, repair leaks or replace defective parts. Reducing valve must be returned to manufacturer for repairs.
9. Oxygen Flow Test of Reducing Valve	1. Open main cylinder valve. 2. Open test gauge outlet valve. 3. Press down on bumper plate to open admission valve. 4. Test gauge should read at least ½ PSI. 5. If not ½ PSI, have reducing valve replaced.
10. Safety Valve and Whistle Test	1. Main cylinder valve open. 2. Press bellows in gently and observe test gauge. 3. Whistle should sound between 7 and 9 PSI. 4. If okay, close main cylinder valve, and open admission valve to allow trapped oxygen to escape. 5. If whistle doesn't sound between 7 and 9 PSI, have safety valve replaced.
11. Removing Test Gauge	1. Remove test gauge and reconnect oxygen supply line to reducing valve outlet. 2. Check gasket in oxygen line before connecting.
12. Facepiece and Flexible Hoses Test	1. Visually inspect facepiece and hoses for good condition. 2. Inspect speaking diaphragm. 3. Put on facepiece and adjust for good face-to-facepiece seal. 4. Quickly inhale and exhale, listening for inhalation and exhalation valves to open and close. 5. Operate pressure relief valve plunger to make sure it works. 6. Test inhalation valve and pressure relief valve for leaks:

Steps	Procedure Hints
12. **Facepiece and Flexible Hoses Test (Continued)**	a. Cover exhalation hose opening and exhale into facepiece. b. No air should escape through inhalation valve and pressure relief valve. Replace, if necessary. 7. Test pressure relief valve for airtightness: a. Squeeze exhalation hose shut and exhale into facepiece until pressure builds up in facepiece. b. Quickly open and close relief valve. c. When valve is closed again, try to exhale (with exhalation hose squeezed). d. No air should escape. Replace if necessary. 8. Test exhalation valve and opened pressure relief valve for leaks: a. Cover inhalation hose opening. b. Open pressure relief valve. c. Inhale deeply. d. No air should enter through either valve. Replace if necessary. e. Also, no air should enter through speaking diaphragm, facepiece, or inhalation hose. 9. Test exhalation hose: a. Take off the facepiece and blow forcefully into the end of exhalation hose. b. Air should not escape from hose. Replace if necessary.
12a. Mouthpiece and Flexible Hoses Test	1. Attach rubber mouthpiece. 2. Visually inspect mouthpiece and hoses for good condition. 3. Operate pressure relief valve plunger to make sure it works. 4. Put on mouthpiece and quickly inhale and exhale, listening for inhalation and exhalation valves to open and close.

Steps	Procedure Hints
12a. Mouthpiece and Flexible Hoses Test (Continued)	5. Test exhalation valve, opened pressure relief valve, and inhalation hose for leaks: a. With mouthpiece on, cover opening of inhalation hose. b. Open pressure relief valve. c. Try to inhale. You should not be able to inhale. Repair leaks or replace defective parts. 6. Test inhalation valve, pressure relief valve, and exhalation hose for leaks: a. With pressure relief valve closed, cover the exhalation hose opening, and attempt to exhale into mouthpiece. b. No air should pass through inhalation valve, pressure relief valve, or exhalation hose. c. If necessary repair leaks, or replace defective parts.
13. Assembling the Apparatus	1. Connect rigid hoses to apparatus. 2. Connect facepiece and flexible hoses to rigid hoses.
14. Assembled Apparatus Leak Test	
a. Leak Testing High- and Medium-Pressure Side	1. Close admission valve and open main cylinder valve. 2. Read pressure gauge and close main cylinder valve. 3. Read gauge again. Needle should not move. 4. Locate leaks, if necessary, and repair leaks, or replace parts.
b. Checking Admission Valve	1. Open and close admission valve. 2. When closed, read gauge. Gauge should not fall. 3. If necessary, blow out dirt from valve. Replace the valve, if necessary.
c. Checking Safety Valve	1. Gently squeeze bellows and listen for whistle. 2. If whistle doesn't sound, test it further, and replace if necessary.
d. Leak Testing Low-Pressure Side	1. Squeeze flexible hoses shut and open bypass valve to inflate breathing bag. 2. Press on bag to create pressure. 3. Bag should remain fully inflated. Deflating bag means a leak. Locate leaks, and repair leaks or replace parts.


DISCONNECT O_2
SUPPLY LINE FROM
REDUCING VALVE
OUTLET VALVE →
↖ CONNECTION TO APPARATUS
3
6
9
12
15

Visual 20

Low Pressure Gauge

Demonstration Check 1
PUTTING ON AND TAKING OFF THE McCAA

Person's name ______________________________

Instruct each team member to demonstrate the proper method of putting on and taking off the McCaa. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Putting On the Apparatus

	Yes	No
1. Insert fully charged cylinder and fill regenerator with fresh Cardoxide (if not done already)?	___	___
2. Visually inspect cover, harness, hoses and facepiece?	___	___
3. Attach the breathing hoses and facepiece correctly? (Longer rigid hose connects to regenerator.)	___	___
4. Apply antifog to the inner and outer surfaces of the facepiece lens?	___	___
5. Properly put on the apparatus and adjust for a good fit?	___	___
6. Open the main cylinder valve all the way?	___	___
7. Put on the facepiece correctly?	___	___
8. Properly check the:		
facepiece seal?	___	___
inhalation valve?	___	___
exhalation valve?	___	___
pressure relief valve?	___	___
9. Properly purge normal air from the apparatus and then flush the apparatus with oxygen?	___	___
10. Check the bypass valve and completely close it when finished?	___	___
11. Check the chest pressure gauge?	___	___

Taking Off the Apparatus

Did the person:

	Yes	No
1. Correctly remove the facepiece before closing the cylinder valve?	___	___
2. Carefully unfasten and loosen harness straps and carefully slip the apparatus off?	___	___

Demonstration Check 2
CLEANING AND DISINFECTING THE McCAA

Person's name ______________________________

Instruct each team member to demonstrate the proper method of cleaning and disinfecting the McCaa. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

(Note: It may not be necessary for the team member to actually wash, rinse, and dry the parts. Have the person "go through the motions," so to speak, telling you how to properly wash, rinse, and dry the parts.)

Did the person:	Yes	No
1. Disconnect the facepiece and hoses from the apparatus, and separate the rigid from the flexible hoses?	___	___
2. Remove the cover and oxygen cylinder from the apparatus?	___	___
3. Shake out all the used Cardoxide from the regenerator and brush out all the particles?	___	___
4. Replace the regenerator cap?	___	___
5. Wash all hoses and facepiece in a cleansing solution?	___	___
6. Take apart the speaking diaphragm and wash each part in a cleansing solution?	___	___
7. Disinfect all washed parts in a properly diluted disinfectant solution?	___	___
8. Rinse all disinfected parts in clear, warm water?	___	___
9. Let the parts dry thoroughly before repacking them?	___	___
10. Properly replace the speaking diaphragm in the facepiece?	___	___

Demonstration Check 3
TESTING THE McCAA

Person's name ______________________________

Instruct each team member to demonstrate the proper method of testing the McCaa. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Step 1: Visual Inspection

Did the person:	Yes	No
1. Check harness and cover for good condition?	___	___

Step 2: Cylinder Valve Assembly Leak Test

1. Cap main cylinder valve opening?	___	___
2. Open main valve?	___	___
3. Immerse cylinder neck and valve assembly in water and check for leaks?	___	___
4. Close main valve and remove cap?	___	___
5. Put cap on bypass valve opening and open bypass valve?	___	___
6. Immerse valve assembly in water and check for leaks?	___	___

Step 3: Removing Moisture From Cylinder

1. Hold cylinder neck downward, away from his or her body and quickly open and close main valve?	___	___

Step 4: Filling the Regenerator (if apparatus is worn right after test)

1. Make sure regenerator is clean?	___	___
2. Completely fill regenerator with Cardoxide?	___	___
3. Replace regenerator cap?	___	___

Step 5: Inserting Oxygen Cylinder

1. Insert a "+" rated oxygen cylinder with 165 atmospheres of oxygen in it.	___	___
2. Hook up bypass line to bypass valve.	___	___
3. Tighten metal strap.	___	___

Yes No

Step 6: Connecting the Low-Pressure Test Gauge

1. Disconnect oxygen supply line and insert test gauge between outlet of reducing valve and oxygen supply line? ____ ____

Step 7: Reducing Valve Pressure Test

1. Open main cylinder valve? ____ ____
2. Close outlet valve on test gauge and read test gauge to see if it is steady and between 3 and 4½ PSI? ____ ____

Step 8: Reducing Valve and Pressure Gauge Leak Test

1. (With test gauge outlet valve closed and chest gauge valve open) Read both gauges, close main cylinder valve, and read both gauges again to make sure the readings don't fall? ____ ____
2. If there are leaks: Brush on leak-finding solution to locate leak? ____ ____

Step 9: Oxygen Flow Test of Reducing Valve

1. Open main cylinder valve and test gauge outlet valve? ____ ____
2. Press down on bumper plate to open admission valve? ____ ____
3. Read test gauge to see if it reads at least ½ PSI? ____ ____

Step 10: Safety Valve and Whistle Test

1. With main cylinder valve open, squeeze bellows and read test gauge to see if whistle sounds between 7 and 9 PSI? ____ ____
2. If okay, close main valve and open admission valve to allow trapped oxygen to escape? ____ ____

Step 11: Removing Test Gauge

1. Remove test gauge and reconnect oxygen supply line to reducing valve outlet? ____ ____
2. Check gasket in oxygen line before connecting? ____ ____

Step 12: Facepiece and Flexible Hoses Test

1. Visually inspect facepiece and hoses for good condition? ____ ____
2. Inspect speaking diaphragm? ____ ____
3. Put on facepiece correctly and adjust for good face-to-facepiece seal? ____ ____

Facepiece and Flexible Hoses Test (Cont'd)

	Yes	No
4. Inhale and exhale listening for inhalation and exhalation valves to open and close?		
5. Operate pressure relief valve plunger to make sure it works?		
6. Properly test inhalation valve and pressure relief valve for leaks?		
7. Properly test pressure relief valve for airtightness?		
8. Properly test exhalation valve and opened pressure relief valve for leaks?		
9. Properly test exhalation hose?		

Step 12a: Mouthpiece and Flexible Hoses Test

1. Attach rubber mouthpiece?		
2. Visually inspect mouthpiece and hoses for good condition?		
3. Operate pressure relief valve plunger to make sure it works?		
4. Put on mouthpiece correctly?		
5. Quickly inhale and exhale, listening for inhalation and exhalation valves to open and close?		
6. Properly test exhalation valve, opened pressure relief valve, and inhalation hose for leaks?		
7. Properly test inhalation valve, pressure relief valve, and exhalation hose for leaks?		

Step 13: Assembling the Apparatus

1. Correctly connect rigid hoses to apparatus?		
2. Correctly connect facepiece and flexible hoses to rigid hoses?		

Step 14: Assembled Apparatus Leak Test

Leak-Testing High- and Medium-Pressure Side

1. Close admission valve and open main cylinder valve?		
2. Read pressure gauge, close main cylinder valve, and read gauge again to see if gauge needle remains steady?		
3. Locate leaks, if necessary?		

Yes No

Checking Admission Valve

1. Open and close admission valve? ___ ___
2. Read gauge to see if needle falls? ___ ___
3. If necessary, blow out dirt from admission valve to clear it? ___ ___

Checking Safety Valve

1. Gently press bellows and listen for whistle? ___ ___
2. If whistle doesn't sound, test it further? ___ ___

Leak Testing Low-Pressure Side

1. Squeeze flexible hoses shut and open bypass valve to inflate bag? ___ ___
2. Press on bag to create pressure and watch bag to see if it remains fully inflated? ___ ___
3. Locate leaks if necessary? ___ ___

Suggested Wearing Schedule

The purpose of this wearing schedule is to give new team members a chance to practice wearing an apparatus–breathing, moving, and working with it on. Also they will practice performing team checks.

The three sessions of the wearing schedule are designed to be progressively more demanding. This wearing schedule is provided as a guide. You can tailor it to fit the conditions at your mine site and the needs of your team.

Prior to any practice procedures that involve wearing SCBA, the prospective mine rescue team member should be familiar with the construction, assembly, testing, and care of the apparatus being used, and should have met the physical requirements for mine rescue team membership as outlined in 30 CFR, Part 49.

During the initial training sessions, the instructor should monitor the condition of each member closely. Besides checking each team member's general physical condition, the instructor should be on the lookout for signs of potential trouble like these:

1. Rapid, shallow breathing by trainee (indicates inexperience in breathing with an apparatus)

2. Excessively heavy breathing (indicates trainee is excited)

3. Facepiece fit

    a. Too loose–indicated by:

        (1) Shifting of facepiece during activity
        (2) Failure to maintain facepiece seal

    b. Too tight–indicated by:

        (1) Red marks on face when facepiece is removed
        (2) Trainee complains of headache

4. Excessive use of bypass valve by trainee. If apparatus is functioning properly, this indicates:

    (1) Lack of confidence in apparatus
    (2) Poor physical condition of trainee
    or
    (3) Improper breathing technique

5. Rapid consumption of O_2 supply by trainee. If apparatus is functioning properly, this indicates:

(1) Lack of confidence in apparatus

(2) Poor physical condition of trainee

(3) Excited condition of trainee

or

(4) Improper breathing technique

TEAM CHECKS FOR McCAA

The team should make an initial check when they put on their apparatus and then stop every 15 to 20 minutes thereafter to make checks.

At each rest stop the team member should be asked if he or she is okay and fit to continue the exercise.

A team check should also include the following:

1. Check of pressure gauge

2. Visual check of facepiece seal

3. Check that apparatus harness is properly adjusted and has not moved during the exercise

4. Blowing off nitrogen

During an actual rescue operation the team captain should carry out these checks, and he or she, in turn, should be checked by the co-captain, but during these practice exercises each trainee should be given the opportunity to carry out a check of the other team members. This will ensure that each team member is familiar with the steps and procedures included in a team check and blow off.

SESSION 1

It is suggested that the first session be held on the surface. This session should serve primarily to introduce the new trainee to wearing the apparatus. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Walk at normal speed on level ground (for 10 minutes) to allow trainees to become accustomed to the apparatus.

3. Rest 5 minutes, breathing normally. Check apparatus and condition of team members and blow off.

4. Walk over obstructed course, or rough terrain, or climb small hills (10-15 minutes).

5. Rest 5 minutes, breathing normally. Check apparatus and condition of team members and blow off.

6. Each carry a 30 to 50 pound weight (a bag of rock dust, sand, fire extinguisher, etc.) for a distance of approximately 100 yards.

7. Rest 5 minutes, breathing normally. Check apparatus and condition of team members and blow off.

8. Walk on level ground until 45 minutes to one hour of apparatus wearing has been completed. (Perform necessary team checks and blow offs.)

SESSION 2

It is suggested that this session be held underground if possible. Have the team perform a physically demanding task while under oxygen so they will begin to understand the limitations imposed upon them by self-contained breathing apparatus. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Select a stopping (or bulkhead) or other point that they can walk to and inspect (traveling should take about 15 to 20 minutes).

3. Rest 5 minutes, breathing normally. Check apparatus and condition of team members and blow off.

4. Perform some physical activity such as loading a mine car with rock dust, sand, timber, etc. or building a stopping (or bulkhead) or other physically demanding activity. Have the team perform team checks and blow off every 15 to 20 minutes while doing this.

5. Return to surface.

SESSION 3 (Apparatus training in smoke and/or further activities without smoke)

During this session it would be helpful to expose the team to smoke so that they can experience working in smoke and wearing an apparatus under conditions of limited visibility.

If your mining operation is such that a smoke bomb can be used safely underground, this is the most desirable situation. If this is not possible, any confined area–old building, trailer, or a structure made of brattice cloth or plastic–can be used as a smoke room.

Only Step 4 of this session is designed for use in smoke. An alternate Step 4 is also supplied if smoke cannot be used. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Spend the next 45 minutes to an hour traveling in conditions that approximate the type of conditions they'll encounter in their mine, i.e., climbing ladders, crawling or duck walking in low roof conditions, walking over rough terrain, up and down inclines, etc. Have team stop for team checks and blow off every 15 to 20 minutes.

3. Enter smoke area. Before doing this, the team should stop for a team check and blow off. Trainees should pay special attention to their facepiece seals to ensure a proper seal–not too loose or too tight.

Procedures that can be stressed and practiced during the team's time in smoke are:

1. Experiencing the disorientation that can occur in heavy smoke.

2. The use of a linkline or lifeline to keep team members together.

3. Following a rail (or a 2 inch x 4 inch board for a substitute rail).

4. Feeling and following the rib or side (or wall in a building).

5. Team communications in smoke.

The exercise should be designed so that the team spends no longer than 20 to 30 minutes in smoke. Team should make verbal team checks and blow off the apparatus as necessary and have a complete team check immediately upon leaving the smoke area.

ALTERNATE STEP 4 (If smoke is not used.)

If you are not using smoke, have the team engage in physical activity related to mine rescue, such as carrying a weighted stretcher or stoke's basket, or carrying supplies or objects, such as lumber, timbers, or rolls of brattice. These should be tasks that require more than one person. This activity should take 20-30 minutes. Have team make checks and blow off as necessary.

Instructor's Note: This three-session wearing schedule is intended to introduce the trainee to wearing apparatus under a variety of conditions. In annual refresher training the trainees will be performing advanced rescue and recovery procedures while wearing the apparatus.

Mouthpiece

Description

Visual: Display the mouthpiece and point out the following parts.

The mouthpiece assembly is made up of a "T" shaped metal valve housing. This contains the inhalation and exhalation valves, and a pressure relief valve connected to the bottom of a saliva trap barrel. A rubber mouthpiece and noseclip are also attached to the housing.

When wearing, the rubber mouthpiece fits snugly between your lips and teeth and is held in place by straps attached to the mouthpiece that are fastened or buckled to a suitable cap or head strap. You must use a noseclip to close your nostrils when wearing the mouthpiece.

The "Nod and Shake" goggles used with the mouthpiece are used to protect your eyes if you are in smoke. The goggles are called "Nod and Shake" because there are cups of water at the bottom of each eyepiece. When you nod and shake your head, the water comes out and clears any fog on the eyepieces.

Inhalation and Exhalation Valves

The inhalation and exhalation valves are designed to help keep air flowing in a one-way direction. The inhalation valve on the left side of the mouthpiece (when wearing) allows air to flow into the mouthpiece. The exhalation valve on the right permits air to flow out of the mouthpiece.

Demonstration: Remove the breathing hoses from the mouthpiece so as to expose the inhalation and exhalation valves. Then put on the mouthpiece and noseclip and breathe, demonstrating how the valves open separately (as you inhale and exhale) to keep the air flowing in one direction.

Keep in mind that in a closed-circuit breathing apparatus it is very important to keep the air flowing in one direction. If it didn't you'd risk breathing in exhaled air filled with carbon dioxide, or else fresh oxygen might not reach you.

Pressure Relief Valve

The pressure relief valve is the metal unit which extends from the bottom of the valve housing. The relief valve is a hand-operated valve that you open by pushing in on the plunger at the bottom of the unit. When the valve is open, air can be vented to the outside by blowing out through the valve.

If you have ever watched teams wearing McCaas, you may have noticed that they stop every 15 minutes to "blow off." This involves forcefully exhaling through the relief valve in order to purge the unit of nitrogen. The reason for this is that the McCaa does not automatically vent excess rebreathed air to the outside. So it is necessary for the wearer to "blow off" the excess rebreathed air (mainly nitrogen) which has accumulated in the breathing bag so that fresh oxygen can enter the bag through the admission valve.

Note: How and when the relief valve is used will be described later on in the "Wearing the Apparatus" section of this training module.

The pressure relief valve works in conjunction with another valve called the check valve. This check valve prevents the outside air from entering the facepiece when the pressure relief valve is open.

Demonstration: Unscrew the relief valve from the valve housing and point out the rubber gasket and spring as you discuss them in the following section.

The relief valve can be unscrewed from the valve housing. There is a rubber gasket at the threaded connection. Inside the relief valve housing there is a spring which keeps the valve shut except when manually opened.

When reassembling the relief valve, always make sure the spring is correctly placed. Incorrect placement will foul the operation of the check valve.

Putting On the Apparatus and Mouthpiece

Before putting on your apparatus, make sure that all the necessary tests and maintenance have been performed on it. The apparatus must have a properly charged oxygen cylinder in it along with fresh Cardoxide in the regenerator.

Note: Testing and maintaining the apparatus will be covered in detail later on in the "Bench Duties" section of the module.

When all of these things have been taken care of, you are ready to put on the apparatus.

Demonstration: As you discuss the following procedure, either put on the apparatus yourself, or have a team member put it on as you describe the procedure.

To put on the apparatus properly:

1. First, visually inspect the protective cover, harness, hoses, and mouthpiece to make sure they are in good condition.

Note: Filling the regenerator with Cardoxide is explained in the "Bench Duties" section of the lecture.

2. Fully assemble the apparatus by attaching the breathing hoses and mouthpiece to the apparatus. Remember, the longer rigid hose is the exhalation hose and it connects to the regenerator.

3. With the apparatus fully assembled, you are ready to put on the unit. Slip your arms through the shoulder straps, one at a time. Once you have the apparatus on your back, adjust the shoulder straps for a comfortable fit. Then buckle the waist belt and chest strap for a snug fit. Make sure to fasten the rigid hoses to the chest strap before you buckle the strap.

4. Open the main cylinder valve all the way.

5. Place the rubber mouthpiece in your mouth. Adjust and fasten the straps so that the mouthpiece is held firmly in place.

Once you have the mouthpiece in place, there are four things you have to do immediately before you can safely use the apparatus:

1. Purge all the normal air from the apparatus and flush the apparatus with fresh oxygen;
2. Check the bypass valve;
3. Check the pressure relief valve; and
4. Check the pressure gauge.

Demonstration: Have someone demonstrate the following procedures as you describe them below.

Flushing With Oxygen

With the main cylinder valve shut, you are going to "purge" all the normal air from the apparatus to make the most room for fresh oxygen. This procedure involves inhaling air from the apparatus and exhaling it to the outside through your nose until the apparatus is completely emptied. Then you are going to open the main cylinder valve and continue to purge air from the apparatus to completely flush the apparatus with oxygen.

To do this procedure properly:

1. Close the main cylinder valve.

Note: Team members may wish to keep their right hands on the cylinder valve to eliminate the panic factor when the apparatus is evacuated.

2. Inhale deeply from the apparatus and exhale through your nose to the outside air (with the cylinder valve shut).

Note: It is suggested that team members bend over from the waist as they exhale. This process of bending over helps one to exhale more forcefully and completely.

Repeat this procedure until the apparatus is completely emptied of all its air.

3. When the apparatus is emptied of its air, open the main cylinder valve completely and lock it in position by attaching the safety chain.

Note: The chain, remember, prevents the main valve from being accidentally closed.

4. Now repeat the procedure of inhaling from the apparatus and exhaling to the outside to get the oxygen from the cylinder to flush the apparatus. You should repeat this procedure at least three times in order to get the oxygen to completely fill the apparatus.

Note: Again, it is suggested that the team members bend over as they exhale.

This process of purging the apparatus of normal air and flushing it with oxygen is extremely important. If you do it properly, a large amount of nitrogen will be expelled from the apparatus and you will be provided with air containing a high percentage of oxygen.

Checking the Bypass Valve

Open the bypass valve momentarily to make sure it is working properly. You should be able to hear the flow of oxygen.

When you're finished with the test, make sure that you completely close the bypass valve. A partially open valve will waste oxygen and cause a pressure buildup in the apparatus.

Checking the Pressure Relief Valve

In order to test the mouthpiece's pressure relief valve, place the noseclip snugly on your nose. You will know if the noseclip is tight enough if you find it impossible to inhale or exhale through your nose.

Now, pinch the exhalation hose (on your right) closed and open the pressure relief valve by pushing in on the plunger. Then exhale forcibly to the outside air through the open relief valve to make sure that the valve is working properly.

Checking the Pressure Gauge

Finally, check the pressure gauge to make sure that the gauge valve is open and that you have 150 atmospheres of oxygen in the cylinder.

Taking Off the Apparatus and Mouthpiece

Demonstration: As you discuss the following procedure, demonstrate how to properly take off the apparatus.

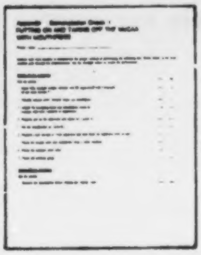
The proper method of removing the apparatus is:

1. **First, loosen the mouthpiece straps and remove the mouthpiece.**

2. **Close the main cylinder valve.**

3. **Unfasten the harness's waist and chest straps, loosen the shoulder straps and slip the apparatus off your back.**

Demonstration check: Have the team members put on the apparatus, check it for proper functioning, and take off the apparatus. Use copies of *Appendix Demonstration Check 1–Putting On and Taking Off the McCaa with Mouthpiece,* provided at the back of this Appendix to check each team member's performance. Review the results with each team member.



Mouthpiece Limitations

While wearing the mouthpiece you will not be able to speak. If you wear the "Nod and Shake" goggles with the mouthpiece, your visibility will be limited.

Testing the Mouthpiece and Flexible Hoses

Demonstration: Demonstrate the following procedure for testing the mouthpiece and hoses. Either demonstrate it yourself or have a team member do it as you describe the procedure.

The procedure for testing the mouthpiece and its valves and flexible hoses is as follows:

Note: The flexible hoses should be attached to the mouthpiece.

1. First attach the rubber mouthpiece to the metal valve housing and carefully examine all mouthpiece and hose parts for cracks, tears, and other signs of wear. Bend the hoses back and forth several times to make sure they're flexible. Check the hose clamps for tightness and make sure the hose gaskets are in place and in good condition. Replace the gaskets if they are in bad condition. And don't forget to examine the mouthpiece straps.

2. Operate the pressure relief valve plunger several times to make sure that it moves freely.

3. Put the rubber mouthpiece in your mouth and breathe through it several times to see if you can hear the inhalation and exhalation valves opening and closing.

4. Now check the exhalation valve and the pressure relief check valve to make sure that air cannot be inhaled through them. This test also checks the inhalation hose for leaks.

Put the rubber mouthpiece in your mouth and cover the opening of the inhalation hose (on the left when wearing) with the palm of your hand. Open the pressure relief valve using your other hand. Try to inhale through the mouthpiece.

You should not be able to draw in any air indicating that the exhalation valve and pressure relief check valve are properly functioning. No inward leakage on this test also means that the inhalation hose is not leaking.

Any parts that leak will have to be replaced.

5. To test the inhalation valve, pressure relief valve, and exhalation hose: With the pressure relief valve closed, cover the opening of the exhalation hose (on the right) and attempt to exhale into the mouthpiece.

   No air should pass through the inhalation valve or the pressure relief valve indicating that these valves are functioning properly to prevent air from being exhaled through them. No outward leakage also means that the exhalation hose is free of leaks.

   Any parts that leak will have to be replaced.

6. Remove the mouthpiece.

Leak Testing in Water

Note: Leak testing in water is an alternate method of checking for leaks in the mouthpiece and hoses. Also, if you have found a leak in the previous test, testing in water can be used to determine if the leak is in the valve itself.

In order to locate leaks in the mouthpiece and hoses, it may be necessary to immerse the parts in water and check for air bubbles.

1. To test for leaks in the hoses, metal mouthpiece and pressure relief valve: Close the exhalation hose opening (on the right when wearing) with your hand or a plug. Close the opening of the rubber mouthpiece with a thumb or plug. Immerse everything, except the end of the inhalation hose, in water. Exhale forcefully through the inhalation hose and look for air bubbles in the water.

   Any parts that leak will have to be replaced.

   Be sure to remove any plugs you have used before going on.

2. To test the inhalation valve for leaks: Put the mouthpiece in your mouth and squeeze the exhalation hose (on the right) shut. Place the end of the inhalation hose in water and exhale forcefully into the mouthpiece.

   If air bubbles emerge from the inhalation hose opening, it means the inhalation valve is leaking and allowing air to be exhaled through it.

A leaking inhalation valve has to be replaced.

3. To test the exhalation valve for leaks: Immerse the mouthpiece in water and exhale forcibly into the exhalation hose. If air bubbles emerge from the mouthpiece, the exhalation valve leaks and will have to be replaced.

4. To test the pressure relief check valve for leaks: Remove the pressure relief valve from the valve housing, and immerse the rubber mouthpiece in water. Exhale forcefully into the relief valve connection or the mouthpiece unit.

   If air bubbles emerge from the mouthpiece, the pressure relief check valve will have to be replaced.

   When reassembling the relief valve, always make sure the spring is correctly placed. Incorrect placement will foul the operation of the check valve. Also make sure that the spring and valve gasket are in good condition.

Appendix Demonstration Check 1
PUTTING ON AND TAKING OFF THE McCAA AND MOUTHPIECE

Person's name ________________________________

Instruct each team member to demonstrate the proper method of putting on and taking off the apparatus and mouthpiece. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Putting On the Apparatus

Did the person:	Yes	No
1. Insert fully charged oxygen cylinder and fill regenerator with Cardoxide (if not done already)?	___	___
2. Visually inspect cover, harness, hoses and mouthpiece?	___	___
3. Attach the breathing hoses and mouthpiece correctly? (Longer rigid hose connects to regenerator.)	___	___
4. Properly put on the apparatus and adjust for a good fit?	___	___
5. Put the mouthpiece on correctly?	___	___
6. Properly purge normal air from apparatus and then flush the apparatus with oxygen?	___	___
7. Check the bypass valve and completely close it when finished?	___	___
8. Check the pressure relief valve?	___	___
9. Check the pressure gauge?	___	___

Taking Off the Apparatus

Did the person:		
1. Correctly remove the mouthpiece before closing the cylinder valve?	___	___
2. Carefully unfasten and loosen harness straps and carefully slip off the apparatus?	___	___

McCaa General Review

Directions: Select the correct answer to each of the following questions.

1. **When and how do you use the bypass valve?**
   - a. **Open and leave open when working hard.**
   - b. **Open and leave open when safety valve whistle blows.**
   - c. **Open and close quickly and repeatedly when you are not receiving enough oxygen or when the safety valve whistle blows.**
   - d. **Open and close quickly and repeatedly to flush the apparatus with oxygen before you wear the apparatus.**

2. All of the following procedures should be done just prior to wearing the McCaa except:
   - a. Leak testing high- and medium-pressure parts.
   - b. Checking the bypass valve.
   - c. Checking the inhalation and exhalation valves.
   - d. Testing the cylinder safety cap.

3. What would happen in the apparatus if you did not blow off accumulated nitrogen from the apparatus?
   - a. Carbon dioxide content would increase.
   - b. Oxygen content would increase.
   - c. Oxygen content would decrease.
   - d. Carbon monoxide content would decrease.

4. Pick out two limitations of wearing the McCaa:
   - a. Two-hour use limit.
   - b. Buildup of carbon dioxide in breathing bag.
   - c. Lack of gauge indicating amount of oxygen in cylinder.
   - d. Fogging of the facepiece.

5. While wearing the apparatus, two things you must do periodically are:
   - a. Check the safety valve and check the Cardoxide level.
   - b. Check the pressure gauge and blow off through the pressure relief valve.
   - c. Check the pressure relief valve and blow off through the safety valve.
   - d. Adjust the harness and check the Cardoxide level.

6. To fill the regenerator, you will have to:
   - a. Remove regenerator from apparatus and fill one-half full with Cardoxide.
   - b. Remove regenerator cap, fill regenerator one-half full with Cardoxide, and replace cap.
   - c. Remove regenerator cap, completely fill regenerator with Cardoxide, and test before putting on regenerator cap.
   - d. Remove regenerator cap, completely fill regenerator with Cardoxide, and replace cap.

7. What should you do if you notice the pressure gauge of your McCaa is not working?

a. Open bypass valve and continue working.

b. Shut the pressure gauge valve and return to fresh air.

c. Shut the main cylinder valve and open the bypass valve.

d. Open the bypass valve and return to fresh air.

8. Before filling an oxygen cylinder you should:

a. Check the hydrostatic test date.

b. Check that the apparatus has been fully tested.

c. Check the pressure service rating.

d. a and b.

e. a and c.

9. Testing of the McCaa should be done on the following schedule:

a. Once every 30 days.

b. Once every 3 months.

c. Each time before you wear it.

d. a and c.

10. After you put on the facepiece, what procedures do you perform before using the apparatus?

a. Check the facepiece seal.

b. Check the safety valve.

c. Flush with oxygen.

d. a and c

e. a and b.

11. When you cap off the main cylinder valve, open the main cylinder valve, and immerse the valve assembly and neck of the cylinder in water, you are testing for:

a. Moisture in the cylinder.

b. Leaks in safety cap.

c. Leaks in cylinder walls.

d. Leaks in main cylinder valve stem, neck of cylinder, and opening of bypass valve.

12. To test that safety whistle operates at the correct pressure:
    a. Gently squeeze the reducing valve bellows and watch that the needle on the chest gauge does not fall.
    b. Gently squeeze the reducing valve bellows and check that the low-pressure test gauge registers 7 PSI when the whistle sounds.
    c. Gently squeeze the reducing valve bellows and check that the low-pressure test gauge registers between 7 and 9 PSI when the whistle sounds.
    d. Gently squeeze the inflated breathing bag and check that the low-pressure test gauge registers between 7 and 9 PSI when the whistle sounds.

13. Each of the following is part of the Assembled Apparatus Leak Test except:
    a. Leak testing high- and medium pressure side.
    b. Checking admission valve.
    c. Checking flow pressure on reducing valve.
    d. Checking safety valve.
    e. Leak testing low-pressure side.

14. The oxygen flow pressure on the reducing valve should be:
    a. Between 3 and 4½ PSI.
    b. At least ½ PSI.
    c. Between 7 and 9 PSI
    d. Between 135 and 150 atmospheres.

15. Which statement is false:
    a. Cardoxide can be used once only.
    b. Make sure the Cardoxide you use is from a sealed container.
    c. Under normal conditions the pressure gauge valve should be open when wearing an apparatus.
    d. When you need to use the bypass system, make sure you open the bypass valve only halfway.
    e. Use your bypass sparingly.

General review answers:

1. c
2. d
3. c
4. a and d
5. b
6. d
7. b
8. e
9. d
10. d
11. d
12. c
13. c
14. b
15. d

Glossary

atmosphere A unit of pressure equal to approximately 14.7 PSI.

baffle A device used to deflect, check, or regulate the flow of air.

Cardoxide The soda lime mixture used in the McCaa's regenerator to absorb carbon dioxide.

compressed oxygen Gaseous oxygen that is contained under high pressure.

hydrostatic test A test performed on oxygen cylinders every 5 years to check the cylinder's elasticity. (Water is pumped into the cylinder to a pressure greater than the cylinder's pressure service rating to measure how much the cylinder expands.)

pressure service rating The maximum pressure to which an oxygen cylinder can be filled. (Usually measured in PSI and stamped on the neck of the cylinder).

PSI Pounds per square inch.

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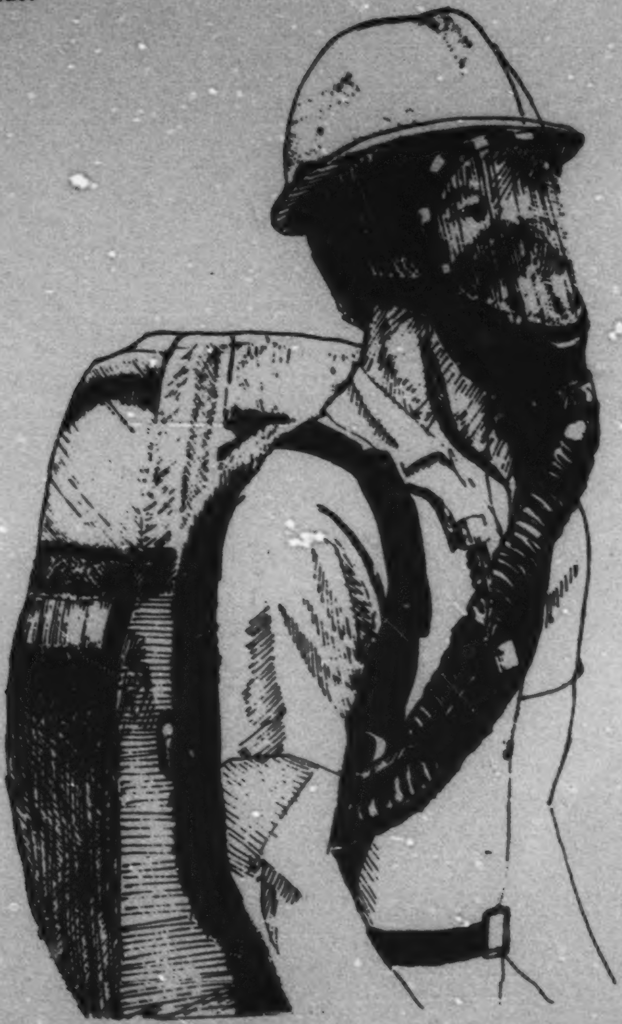
Scott Rescue–Pak Self–Contained Breathing Apparatus

Coal

Training Module–Initial Mine Rescue

U.S. Department of Labor
Mine Safety and Health Administration
Education and Training Directorate
November 1981

MSHA 2007



Scott Rescue-Pak Self-Contained Breathing Apparatus

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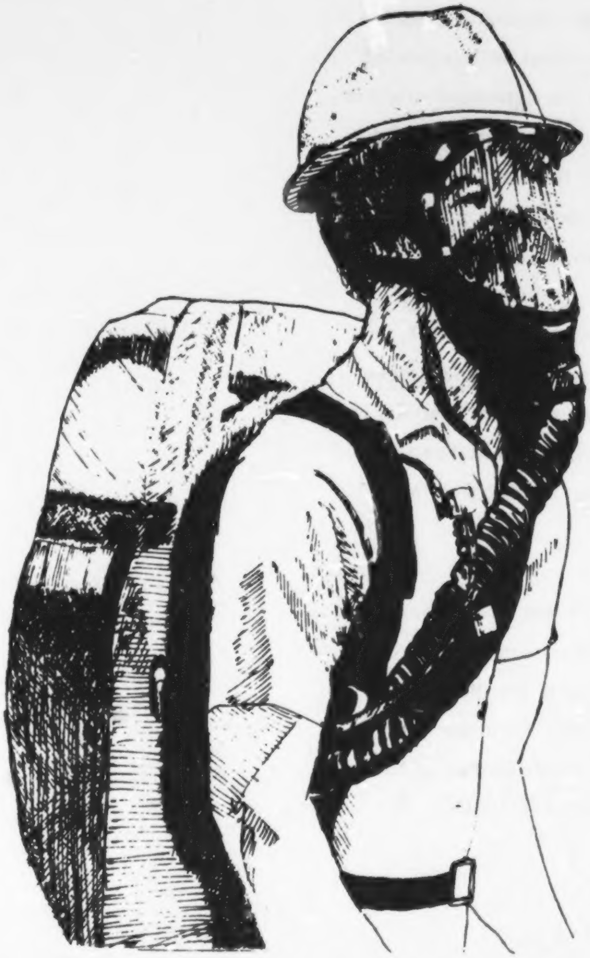

ABOUT THE TRAINING MODULES:

The modules are designed to implement the training of the Nation's mine rescue team members as mandated by Part 49, Subchapter H, Chapter I, Title 30, Code of Federal Regulations pursuant to the Mine Safety and Health Act of 1977. Each of the modules covers a separate subject in a self-contained unit with suggested handouts and visual material to aid in its presentation. They are designed specifically for the training of underground inexperienced or experienced mine rescue team members.

Training module MSHA 2001, Instructor's Manual for Mine Rescue Training, contains a list of modules in the training program as well as a glossary that can be useful to the instructor.

This program was developed by the Mining Extension Service of West Virginia University for the Mine Safety and Health Administration under United States Bureau of Mines Contract Number JO308002.

Scott Rescue-Pak
Self-Contained Breathing Apparatus

Training Module–Initial Mine Rescue

U.S. Department of Labor
Raymond J. Donovan, Secretary

Mine Safety and Health Administration
November 1981

MSHA 2007

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Course Objectives

Main objective

The mine rescue team member will be able to properly use and maintain the Scott four-hour self-contained breathing apparatus.

Supportive objectives

The team members will:

1. **Describe the Scott four-hour self-contained breathing apparatus and explain what happens in the apparatus during inhalation and exhalation.**

2. **List the major parts of the Scott Rescue-Pak and describe their function:**

   a. Wearing harness
   b. Cover and shell
   c. Cylinder
   d. Frangible disc safety assembly
   e. Cylinder pressure gauge
   f. Cylinder valve
   g. Attachment bolt and bleed assembly
   h. Regulator
   i. High pressure relief valve
   j. Automatic warning alarm
   k. Manual mainline valve
   l. Manual gauge shutoff
   m. Remote pressure gauge
   n. Manual bypass valve
   o. CO_2 scrubbing canisters
   p. Heat exchanger
   q. Mixing chamber
   r. Breathing bag
   s. Demand valve
   t. Low pressure relief valve
   u. Relief valve shutoff switch
   v. Facepiece and breathing hoses

3. Put on and take off the apparatus correctly and check it for proper functioning.

4. Wear the Scott apparatus and define its limitations when worn.

5. Perform required and recommended testing and maintenance of the Scott Rescue-Pak.

Course Materials

Required:

Handouts and visuals from the back of this module

Pencil and paper for each team member

Scott breathing apparatus

Scott tester

Compressed oxygen

Source of oxygen and cascade system or high pressure oxygen pump

CO_2 scrubbing canisters (training canister and rescue canister)

Disinfectant and cleaning solutions

Anti-fog solution and wiping tissue for facepiece

Wrench for constant flow connection

Suggested:

Overhead projector

Equipment for making copies and/or transparencies

Chalkboard

Optional Resources:

The manufacturer's information which comes packed with the apparatus.

Course Outline

I. The Scott Rescue-Pak
  - A. Description
  - B. How it works

II. Parts of the Scott Rescue-Pak
  - A. The support section
    - 1. Wearing harness
    - 2. Protective cover and Back-Pak shell
  - B. The oxygen supply section
    - 1. Inside the apparatus
      - a. Oxygen cylinder assembly
        - (1) Cylinder
        - (2) Frangible disc safety device
        - (3) Cylinder pressure gauge
        - (4) Attachment bolt and bleed assembly
      - b. The manifold assembly
        - (1) Regulator
        - (2) High pressure relief valve
        - (3) Automatic warning alarm
    - 2. Outside the apparatus
      - a. The manual controls
        - (1) Manual mainline valve
        - (2) Manual gauge shutoff valve and remote pressure gauge
        - (3) Manual bypass valve
  - C. The rebreather section
    - 1. CO_2 scrubbing canister
      - a. Types of canisters
        - (1) Training
        - (2) Rescue
    - 2. Heat exchanger
    - 3. Mixing chamber
    - 4. Breathing bag

5. Demand valve
6. Low pressure relief valve
7. Relief valve shutoff switch
8. Facepiece
   a. Scottoramic
   b. Panorama Nova
9. Breathing hoses
10. Drain tube

III. Emergency backup parts and procedures

IV. Putting on the apparatus

V. Taking off the apparatus

VI. Wearing the apparatus
A. Limitations
1. Weight and size of apparatus
2. Time limit, work rate, and breathing rate
3. Temperature range

VII. Bench duties
A. Cleaning and disinfecting the apparatus
1. Disassembling the apparatus
2. Draining the unit
3. Washing, rinsing, and drying
B. Reassembling and storing the apparatus
C. Oxygen
1. Safety precautions for handling oxygen cylinders
2. Methods for filling oxygen cylinders
3. Checks to make before filling cylinders
4. Precautions for filling oxygen cylinders
5. Procedure for filling Scott oxygen cylinders

D. Apparatus testing
  1. Recordkeeping
    a. Testing records
    b. Maintenance records
    c. Tagging
  2. The Scott portable tester
  3. Testing procedure
    a. Visual inspection
    b. Insert oxygen cylinder
    c. Insert CO_2 scrubbing canister
    d. Constant flow rate
    e. Positive pressure leak test
    f. Relief valve test
    g. Demand valve test
E. Periodic maintenance

Instructor Notes

Note: Throughout this module, the *Visual* notes will recommend that you point out parts, etc., on an actual Scott apparatus. The *Visual* notes will also refer you to various visuals in the back of the module. You should, if possible, make overhead transparencies of the visuals, or sketch them on a chalkboard, or make copies of them to distribute as handouts to the team members (depending on the type of visual).

It is recommended that you use both the apparatus *and* the visuals to aid in an overall understanding of the apparatus. However, the use of one or the other will suffice.

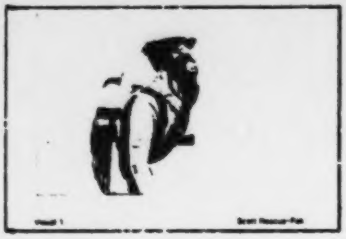
Objective 1: The team members will describe the Scott four-hour self-contained breathing apparatus and explain what happens in the apparatus during inhalation and exhalation.

Suggested Lecture

THE SCOTT RESCUE-PAK

Visual: Display a Scott apparatus so the team can see it as you begin talking about it and/or refer to "Visual 1" for a picture of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Note: To remove the apparatus from its storage box, put your arms through the straps and lift out the apparatus. Place the unit on a flat surface with the cover facing upward.

At the bottom of the storage box you will notice a flap that is snapped shut. Inside this is the nut driver and charging fitting you will need for the apparatus.

Description

The Scott four-hour Rescue-Pak is a self-contained breathing apparatus that you wear on your back. It removes carbon dioxide from the air you breathe and supplies you with fresh oxygen for up to four hours.

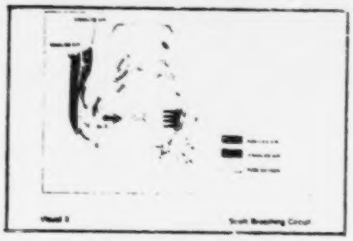
Because the Scott apparatus recycles and replenishes the air you breathe in a continuous cycle completely independent of the air around it, it is a "closed circuit" apparatus.

The Scott is a compressed oxygen system. This means that its oxygen supply is stored under high pressure in an oxygen cylinder attached to the unit. Before it gets to you, this high-pressure oxygen coming from the cylinder travels through a regulator which reduces the oxygen's pressure and regulates its flow.

How It Works

Visual: Trace the flow of air on an apparatus and/or refer to "Visual 2" for a picture of the breathing circuit.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Basically, the Scott apparatus works like this: When you inhale, purified oxygen-enriched air travels from the breathing bag and up the inhalation hose to you. When you exhale, the air you breathe out goes down the exhalation hose and passes through a scrubbing canister which removes carbon dioxide, a by-product of the breathing process.

From there, the purified air then passes through a heat exchanger which partially cools it, and on into a mixing chamber. In the mixing chamber, the purified air combines with fresh oxygen which comes from the cylinder.

This oxygen-enriched air then travels to the unit's breathing bag where it's ready to be inhaled, and the whole process begins again.

This gives you a general idea of how the system works. Now lets take a look at each of its parts in detail.

PARTS OF THE SCOTT RESCUE-PAK

Objective 2: The team members will list the major parts of the Scott Rescue-Pak and describe their function:

a. wearing harness
b. cover and shell
c. cylinder
d. frangible disc safety assembly
e. cylinder pressure gauge
f. cylinder valve
g. attachment bolt and bleed assembly
h. regulator
i. high pressure relief valve
j. warning alarm
k. manual mainline valve
l. manual gauge shutoff
m. remote pressure gauge
n. manual bypass valve
o. CO_2 scrubbing canisters
p. heat exchanger
q. mixing chamber
r. breathing bag
s. demand valve
t. low pressure relief valve
u. relief valve shutoff switch
v. facepiece and breathing hoses

To make it a little easier to understand how the Scott Rescue-Pak works, we'll break it down into three groups of parts: (1) The support section, which includes the parts that hold the apparatus in place on your body and those that support and protect the apparatus itself; (2) the oxygen supply system, which consists of the parts that are involved in supplying oxygen to the unit's breathing system; and (3) the rebreather section, which consists of parts that help purify and recirculate the air you breathe.

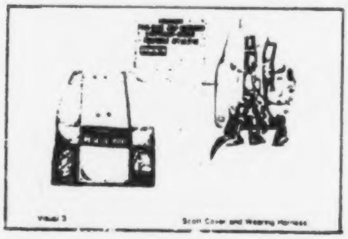
The Support Section

The support section of the Scott apparatus is made up of the parts that protect and support the apparatus—the wearing harness and the protective plastic casing.

The Wearing Harness

Visual: Point out the wearing harness on an apparatus and/or refer to "Visual 3" for a picture of the harness.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The wearing harness is made up of the parts that hold the apparatus in place on your body. The Scott's harness consists of two adjustable padded shoulder straps, an adjustable chest strap, and an adjustable waist belt.

Demonstration: Demonstrate adjusting and fastening the harness straps as you discuss it below. (The team members will learn how to put on the apparatus later on in the lecture.)

The chest and waist belts hook together by means of simple buckle-type fasteners. To adjust them, you feed the webbing through the slotted end of the buckle and pull on it from either side, depending on whether you want to loosen or tighten the strap.

The spring clips on the chest straps are used to adjust the shoulder straps. To work them, simply push down on the spring clip lever and pull the webbed strap through until you get it where you want it. Then let go of the clip. The serrated edge will spring into position to hold the strap in place.

The Protective Cover and Back-Pak Shell

Visual: Point out the cover and shell on an apparatus and/or refer again to "Visual 3" for a picture of these parts.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The inner working parts of the Scott are encased in a two-part protective plastic casing. The top of this casing, known as the cover, lifts off so you can get to the parts inside the unit. The metal mesh grill running from the bottom to the top of the cover helps transfer heat produced within the unit away from you.

The other half of the plastic casing holds and protects the unit's parts. We'll refer to this half as the Back-Pak Shell or the "shell." This is the part of the apparatus that rests against your back when you wear it.

On the back of the shell is the NIOSH/MSHA approval label. This tells you the unit's duration of use (or time limit) and some of its limitations. It also tells you some special precautions to take when you wear the apparatus.

Demonstration: Show how to open and close the apparatus cover as you discuss it. Be sure and point out the two parts of the fastener and how they work.

The cover and shell are held together by four elasticized straps with metal hooks. There is one fastener located on either side of the apparatus and two at the bottom end.

Notice that each fastener consists of two separate straps. On the end of one strap is a metal hook that fits into the slot on the side of the cover. The other strap has a reinforced tab on the end. This "tabbed" strap goes underneath the metal hook so that you can pull on the tab to release the hook.

To remove the cover, put the apparatus down on a stable, flat surface with the cover facing up. Then remove the fasteners from the slots by pulling on the tabs. Once the fasteners are out, you can simply lift the cover off.

To put the cover back on, set it in place so everything lines up properly. Push down gently on the cover and put the fasteners in the slots. Remember to place the "tabbed" strap under each fastener so it will be easy to remove the cover next time.

The Oxygen Supply Section

The Scott's oxygen supply section is made up of all the parts involved in supplying you with oxygen. This includes the cylinder, gauge, pressure reducer, regulator, and other valves inside the apparatus shell. It also includes the remote gauge and the manually operated controls located on the outside of the shell.

Inside the Apparatus

We'll look first at the parts of the oxygen supply section located inside the unit's shell—the oxygen cylinder assembly and the manifold assembly.

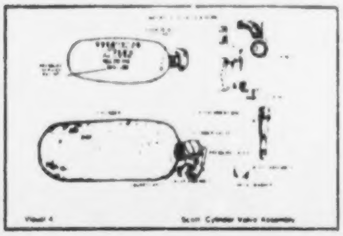
The Oxygen Cylinder Assembly

The oxygen cylinder assembly is made up of these parts: The cylinder, the frangible disc safety device (or "burst" cap), the cylinder pressure gauge, the cylinder valve, and the attachment bolt. These parts are located in the lower or bottom end of the apparatus shell.

The Cylinder

Visual: Remove the oxygen cylinder from an apparatus or have one on hand to point out the various markings and parts as you discuss them, and/or refer to "Visual 4" for a picture of the cylinder.

Use the visual as an overhead transparency, chalkboard sketch, or handout.



The oxygen cylinder, also referred to as the oxygen "bottle," fits horizontally into the bottom end of the shell. This is where the unit's oxygen is stored.

The cylinder is held in place by two elasticized straps that hook into a metal plate on the back of the shell, and by an attachment bolt that screws into the assembly just below the yellow cylinder valve.

Fully charged, the Scott's cylinder holds 435 standard liters of oxygen (1.3 pounds) at a pressure of 1980 pounds per square inch (PSI).

Marked on the outside of the cylinder are two very important bits of information–the pressure service rating and the hydrostatic test date.

The pressure service rating is the 4-digit number printed in large numerals on the side of the cylinder. This is the maximum (highest) pressure to which the cylinder can be filled.

The pressure service rating for the Scott four-hour apparatus is 1980 PSI. This may also be written as 1800 + 10 percent. Either way, you get the same pressure service rating–1980 PSI.

Note: Ten percent of 1800 is 180.
1800 + 180 = 1980 PSI.

Never fill any cylinder to a pressure higher than the total pressure service rating marked on it.

Around the cylinder neck, you'll find a marking known as the hydrostatic test date. It's important for you to know this date because the cylinder must be hydrostatically tested every five years to check it for weakness and leaks. If it has been five or more years since the date stamped on the cylinder, you know it's due for testing. Never fill such a cylinder. Instead, tell your supervisor about it so the cylinder can be properly retested.

Note: When a cylinder is hydrostatically tested, it is filled with water to a pressure greater than its normal operating pressure, forcing the cylinder to expand. The hydrostatic test measures the elasticity of the cylinder as it expands.

Frangible Disc Safety Device

Visual: Point out the frangible disc safety device and/or refer to "Visual 4" for a picture of this part.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

On the left side of the cylinder valve assembly is a small hexagonal metal cap. If you look closely at this, you can see that there are holes in the side of it. This is the frangible disc safety device, or as it is sometimes called, the "burst cap." The burst cap is a safety device designed to keep the cylinder from rupturing if the pressure inside gets too high.

If the cylinder is exposed to extreme heat, for example, the expanding gas will cause the pressure in the cylinder to rise. Before the pressure can get high enough to break the cylinder, the safety disc bursts open, allowing oxygen to escape safely into the atmosphere.

Note: The cap bursts when the cylinder pressure reaches 2650 PSI to 2690 PSI.

Cylinder Pressure Gauge

Visual: Point out the cylinder pressure gauge on the cylinder valve assembly and/or refer again to "Visual 4" for a picture of this part.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The cylinder pressure gauge is the small dial-type instrument on the cylinder valve assembly. This gauge indicates (in pounds per square inch) how much oxygen is in the cylinder. You use this gauge when you fill the cylinder and to check the cylinder pressure before you put the unit on.

The pressure gauge face is numbered from 0 to 20. To tell how much oxygen you have, multiply the number that the needle points to by 100.

Visual: You may wish to write the following figures out on a chalkboard or transparency as you discuss them.

For example, if the needle points to 18, multiply 18 by 100. 18 x 100 = 1800. You read the gauge "1800 PSI." Easier still, just add two zeros to the end of the number the needle points to (for example, 18 + 00 = 1800 PSI.)

If the needle falls halfway between two numbers, read it as 50. For example, if the needle is halfway between 17 and 18, you've got 1750 PSI.

Cylinder Valve

Visual: Point out the cylinder valve on the valve assembly and/or refer to "Visual 4" for a picture of the knob.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The cylinder valve, also referred to as the "on-off knob," is the large yellow knob on the cylinder valve assembly. You turn this knob by hand. Turn it counterclockwise for "on" and clockwise for "off."

Always remember to turn this valve on before you wear the apparatus. If this cylinder valve is not in the "open" position, oxygen cannot flow through the regulator and on into the breathing circuit when you turn on the mainline valve on the outside of the unit.

Note: The mainline valve is the yellow knob located on the outside of the shell (see "Visual 6"). It is a hand-operated valve that allows oxygen to travel into the breathing circuit. The mainline valve will be discussed later in the lecture, but you may wish to point it out here. Explain the difference between the cylinder valve and the mainline valve (i.e., the cylinder valve opens the cylinder, and the mainline valve allows the oxygen to travel into the breathing circuit).

The Attachment Bolt and Bleed Assembly

Visual: Show the team members an attachment bolt and/or refer to "Visual 4" for a picture of the attachment bolt and bleed assembly.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The large bolt that fits through the cylinder valve assembly is the attachment bolt. The attachment bolt "attaches" the cylinder valve assembly to the manifold assembly that, in turn, connects to the Back-Pak shell.

You must take out this bolt in order to remove the cylinder and valve assembly from the apparatus. You also use the attachment bolt to hold the charging fitting in place when you're filling the cylinder.

Visual: Point out the bleed assembly on an attachment bolt and/or point it out on "Visual 4."

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The narrow part of the attachment bolt above the threaded end is known as the "bleed assembly." The bleed assembly is a safety feature designed to allow oxygen which may be trapped inside the valve assembly to "bleed" out if you forget and try to remove the attachment bolt while there is oxygen trapped behind it.

Packed with your Scott apparatus is a nut driver you use to remove and replace the attachment bolt. You'll find it in the unit's storage case.

Demonstration: Show how to remove the cylinder and valve assembly as you discuss it.

Note: Caution: Never remove the cylinder while there is oxygen between the valves. Before you remove the cylinder and valve assembly from the apparatus, check the remote gauge to find out whether there's oxygen trapped between the valves. Pressure between the valves can make it extremely difficult to remove the attachment bolt. If the remote gauge indicates there *is* pressure, eliminate it by depressing the bypass valve until the remote gauge reads "O." If you do not use the bypass valve to eliminate the pressure, damage to the O-rings on the cylinder valve assembly will result. There's also a vent in the regulator where the pressure will bleed out automatically if you forget to use the bypass--but it vents very slowly.

Never try to remove the attachment bolt if there's oxygen escaping from the vent. You may wish to mention this to the team at this point. It appears in more detail later in the lecture.

Visual: Show the team members a metal washer and/or point out this part on "Visual 4."

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Here's how you remove the cylinder and valve assembly from the apparatus: First, detach the two elastic straps that fit over the cylinder by unhooking them from the metal plate. Then use the nut driver to unscrew the attachment bolt.

Once the bolt is out, grasp the cylinder and gently pull down and out on it while turning it slightly counterclockwise. Take care to ease the valve assembly outlet away from the manifold. Then ease the cylinder and valve assembly out of the apparatus.

Under the valve assembly is a metal washer that fits around the hole for the attachment bolt. This may have become dislodged while you were removing the cylinder, so be sure and retrieve it. Always put the washer back in place before you replace the attachment bolt.

Visual: Point out the "O" rings on the valve assembly and/or refer to "Visual 4" for a picture of them.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

While you have the cylinder out of the apparatus, notice the two "O" rings on the valve assembly. There's one on the underside of the valve assembly around the opening for the attachment bolt and another on the valve assembly outlet that fits inside the manifold assembly. It's important for you to know where these "O" rings are because you'll be inspecting and replacing them as part of routine maintenance for the apparatus.

The Manifold Assembly

Visual: Point out the manifold assembly on an apparatus and/or refer to "Visual 5" for a picture of the manifold assembly.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Visual 5
Scott Manifold Assembly

The manifold assembly is the metal housing with small hoses connected to it that is located just above the cylinder valve assembly. The manifold assembly is made up of a number of smaller parts, including the regulator with its two-stage pressure reducer, the high pressure relief valve, and the warning alarm.

The Regulator

Visual: Point out the regulator on an apparatus and/or refer to "Visual 5" for a picture of the regulator.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Your oxygen supply, remember, is stored under high pressure in your unit's cylinder. Before it gets to you, the pressure of this oxygen must be reduced and its flow must be regulated. This is the function of the regulator portion of the manifold assembly.

The regulator contains a two-stage pressure reducer. When the cylinder and mainline valves are open, high pressure oxygen travels from the cylinder into the first stage of the pressure reducer where the pressure is reduced to 60 to 100 PSI. In the second stage, the pressure is reduced to 50 PSI.

Oxygen leaving the regulator flows out at the rate of 1.5 liters per minute. This is known as "constant flow" metering because the oxygen comes out in a steady, measured rate. The 1.5 liters per minute is approximately what you'll consume while you're doing hard work. By contrast, you'll use up only about .8 liters per minute while you're sitting in this room.

Note: If the wearer consumes oxygen faster than 1.5 LPM, a demand valve built into the unit's breathing bag responds by automatically letting more oxygen into the system. This will be covered more fully later in the lecture, but you may wish to mention it here.

High Pressure Relief Valve

Should the first stage of your pressure reducer fail to work, a high pressure relief valve built into the manifold assembly will automatically open and release some of the excess pressure. This high pressure relief valve is a safety feature designed to keep pressure from building up in the demand line and rupturing it.

Automatic Alarm

Visual: Point out the automatic alarm on an apparatus and/or refer to "Visual 5" for a picture of the alarm.

Use this drawing as an overhead transparency, chalkboard sketch, or handout.

The Scott unit's automatic alarm is housed within the open-ended metal box attached to the side of the regulator. Inside the housing is a metal striking pin containing a pressure-sensitive device which "measures" high pressure oxygen. When a certain pressure is reached, the striking pin is activated causing it to hit against the metal housing and make a loud "clattering" sound.

The alarm will sound for about 15 seconds when you have 20 to 25 percent of the fully charged pressure remaining in your cylinder. This happens somewhere between 336 and 532 PSI, so when the alarm sounds for 15 seconds, you know you have roughly 40 to 45 minutes worth of oxygen left.

However, keep in mind that high pressure oxygen activates the alarm and escapes as the alarm sounds. If the alarm port sticks open, oxygen will continue to escape from it, causing the alarm to go off and continue to sound for longer than a minute.

This situation can quickly deplete the unit's oxygen supply. So if your alarm goes off and continues to go off for longer than a minute, you know that you have only about 15 minute's worth of oxygen left in the cylinder.

Note: If this happens, there is a way to conserve the remaining oxygen so it will last longer. You will discuss this method in the "Emergency Backup Parts and Procedures" section later in the lecture.

When it's fully charged, the oxygen cylinder on your unit should contain 1980 PSI. If you insert a cylinder that isn't full or nearly full, soon after you turn on the apparatus the automatic alarm will sound to warn you that you need to fill the cylinder or insert a new one.

Note: The alarm will always sound a warning when the cylinder contains 1400 PSI or less. Pressures as high as 1600 PSI may also activate it.

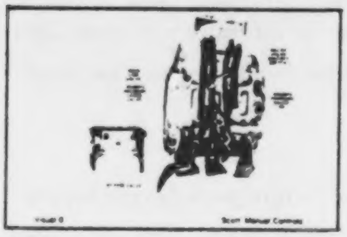
Before you use the unit, check the alarm by opening the cylinder valve and listening for an audible "click." The click indicates that the alarm is setting itself so it will be ready to go off at the proper pressure.

Note: If you have more time, you may wish to let your team hear what the alarm actually sounds like. Here's how: Open the cylinder valve for a second or two, then close it. The alarm will sound as soon as the oxygen "bleeds off" (that is, escapes) from the regulator. It usually takes anywhere from 10-20 or more minutes before the alarm sounds.

Outside the Apparatus

Visual: Point out these parts of the oxygen supply section on an apparatus and/or refer to "Visual 6" for a picture of them.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



All of the oxygen supply section parts we've talked about so far were located inside the apparatus. The ones we'll talk about next are located on the outside of the apparatus so they're within easy reach when you wear the unit. Because you operate most of them by hand, we'll refer to these parts of the oxygen supply section as the "manual controls."

The Manual Controls

The manual controls include: the manual mainline valve, the manual gauge shutoff valve and the remote pressure gauge, and the manual bypass valve.

The Manual Mainline Valve

Visual: Point out the manual mainline valve on an apparatus and/or refer to "Visual 6" for a picture of the valve.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The manual mainline valve is the large yellow knob located just below the approval label on the back of your unit. When you wear the unit, you'll operate this valve with your right hand. It will be the upper of the two knobs on your right-hand side.

You use the mainline valve to turn your oxygen supply "on" or "off." When it's on, the mainline valve lets oxygen flow from the cylinder into the system so you can breathe it.

Note: Be sure the team members know that the cylinder valve ("on-off" knob) *inside* the apparatus must be on before the manual mainline valve can let oxygen into the system.

The mainline valve is equipped with a special locking device to keep you from accidentally closing it. The valve is opened by turning it clockwise.

To close the valve, the outer ring must be pushed in while turning the valve knob counterclockwise.

The Manual Gauge Shutoff Valve and Remote Pressure Gauge

Visual: Point out the manual gauge shutoff valve on an apparatus, and/or refer again to "Visual 6" for a picture of the valve.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The green knob below the mainline valve is the manual gauge shutoff valve. When you're wearing the unit, you can reach this knob with your right hand. It will be the lower of the two knobs on your right-hand side.

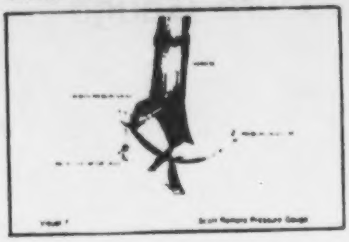
Unlike the mainline valve, you won't be using the gauge shutoff valve every time you use the unit. This valve is a backup safety device designed to be used in case of emergency.

The gauge shutoff valve is normally left open when you're wearing the apparatus. In that position, it allows high-pressure oxygen to travel into the pressure gauge line and on into the remote pressure gauge where it can register your cylinder pressure.

Before we talk more about the gauge shutoff valve and how it works, its important for you to know where the remote pressure gauge and pressure gauge line are located and how they work.

Visual: Point out the remote pressure gauge, pressure gauge line, and protective cap on an apparatus and/or refer to "Visual 7" for a picture of these parts.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The remote pressure gauge is a dial-type instrument like the cylinder gauge inside your unit. The remote gauge, however, is located outside the cover so you can read it easily while you're wearing the unit. It hangs from an elastic strap on the left-hand side of the wearing harness.

To read the remote gauge, pull it out away from the harness until you can see it without bending your head. Then pop off the red protective cover and let it hang from the chain.

You read the remote gauge the same as you do the cylinder gauge: Multiply the number the needle points to by 100, or add two 0's. After you've taken a reading, be sure and replace the red cap.

Now you're probably wondering what the gauge shutoff valve has to do with the remote gauge. The manual gauge shutoff valve controls the oxygen flow into the remote gauge line. In the "closed" position, no oxygen will get into the line, so the remote gauge won't register cylinder pressure.

Normally, you leave the gauge shutoff valve in the "open" position. That's so you will get a remote gauge reading. However, there are times when it's necessary to close the gauge shutoff valve.

If your pressure gauge line ruptures or breaks, or if the pressure gauge itself is broken or damaged, high pressure oxygen can escape, severely limiting the time you'll have under oxygen. So if your remote gauge or the gauge line is damaged while you're wearing the apparatus, turn the gauge shutoff valve clockwise to shut off the oxygen flow to the gauge line.

With the valve in this position, your remote gauge will no longer register cylinder pressure, but you can still tell how much oxygen you have by reading the cylinder gauge. To do this, you'll have to have a team member unhook the fasteners on the unit's cover, lift the cover, and read the cylinder gauge for you.

The Manual Bypass Valve

Visual: Point out the manual bypass valve on an apparatus and/or refer to "Visual 6" for a picture of the valve.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Unlike the controls we've talked about so far, the manual bypass valve is not a knob that you turn one way to open and another way to close. It is a self-closing "button" type valve that you operate by pressing and releasing.

The valve is recessed under the bottom end of the unit's cover. When you're wearing the apparatus, the manual bypass is on your right-hand side so you can operate it with your right hand.

Like the gauge shutoff valve we just talked about, the bypass valve is a backup safety feature designed to be used in case of emergency. It's called a "bypass" valve because pressing it sends a burst of high pressure oxygen directly from the cylinder to where it mixes with purified air and then on to you. Thus, it "bypasses" the parts of the apparatus that regulate the oxygen's pressure.

Use the bypass valve only if your normal oxygen supply route fails to deliver enough oxygen to you while you're wearing the apparatus. Each time you press the valve you'll get a big burst of oxygen, so press in on the valve for only a few seconds, then release it. Wait until you feel the need for oxygen before you press it again.

Because the bypass valve sends high pressure directly to you, using it more than necessary wastes oxygen. Never use it just to "cool" or "freshen" the oxygen you breathe. Use the bypass valve only when absolutely necessary–and when you do, use it sparingly.

The Rebreather Section

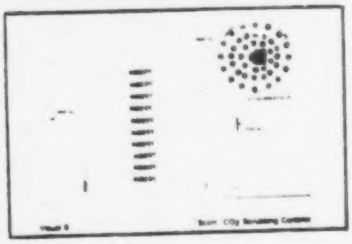
The parts of the apparatus we'll talk about now are involved in purifying and recirculating the air so you can breathe it again. This is called the "rebreather section." In the rebreather section, carbon dioxide is removed from the air you breathe, heat is removed from it, and oxygen is added to it.

The rebreather section consists of these parts: The CO_2 scrubbing canister, the heat exchanger, the mixing chamber, the breathing bag with its demand valve and low pressure relief valve, the facepiece and breathing hoses, and the drain tube.

The CO_2 Scrubbing Canister

Visual: Have a canister on hand to show the team or point it out in the apparatus and/or refer to "Visual 8" for a picture of the canister.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

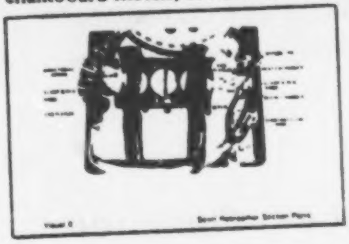


The CO_2 scrubbing canister is a metal box-like container full of an absorbent chemical. The canister fits inside your apparatus above the oxygen cylinder. This is the part of the unit that removes carbon dioxide from your exhaled air. In effect, the canister cleans or "scrubs" the air you breathe so you can breathe it again.

On either end of the canister is an opening with a protective adhesive seal on it. These openings are known as "portals." Further inside either end of the canister are two screens with filters in them that keep the absorbent chemical from spilling out.

Visual: Point out the end plenums, screws and clamp screw knobs on an apparatus and/or refer to "Visual 9" for a picture of these parts.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The canister is connected to the apparatus by means of two cuplike connections inside the shell. These are known as "end plenums," and they fit over the canister portals. When the unit is not in use, the end plenums are covered by protective yellow plastic dust caps. You must always remove both the portal seals and the dust caps before you put a canister in the apparatus.

Note: You may wish to point out the directional arrows on the end plenums and tell the team that these match up with the arrows on the canister to ensure that the canister is inserted properly. This will be discussed later in the lecture.

In the center of each end plenum is a screw that you tighten against the portal to hold the canister securely in place. These screws are operated by means of two black dial-type knobs, known as "clamp screw knobs," located on the opposite end of each plenum. You turn the knobs clockwise to tighten the screws and counterclockwise to loosen them.

Demonstration: Show how to operate the clamp screw knobs as you discuss it here.

Now that you know basically what the scrubbing canister is and what it does, let's take a closer look at how it fits into the Scott's breathing system:

Visual: Using an apparatus, trace the flow of air from the exhalation hose, through the canister, and out again on an apparatus and/or refer again to "Visual 2" as you discuss the air flow.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

When you breathe out, your exhaled air travels down the exhalation hose and enters the scrubbing canister through the entry plenum on the left side. The canister, remember, contains an absorbent chemical which removes carbon dioxide from the air you exhale. Air travels through the canister from left to right in such a way that only purified air emerges from the portal on the right side of the canister. When it reaches this point, the air is ready to be cooled and mixed with fresh oxygen.

Types of Canisters

There are two types of CO_2 scrubbing canisters that may be used with your Scott four-hour apparatus–the training canister and the rescue canister. Both canisters are approximately the same size and shape; they fit into the apparatus the same way; and both use chemicals to purify the air by removing carbon dioxide from it. But there are some very important differences between them. Probably the most important of these differences is the fact that one canister is used for training and the other is approved for actual rescue work.

Visual: Show the team examples of both canisters as you discuss them. Point out their identifying features, markings, etc.

The Training Canister

The training canister is the one you'll probably be most familiar with because you'll be using it during practice and training sessions. This canister is white in color and it's clearly marked "training canister." The absorbent chemical in the training canister is soda lime.

Note: Soda lime is sold under the name "Sodasorb" for Scott apparatus.

The Rescue Canister

The rescue canister is the only canister that is approved by MSHA and NIOSH for actual rescue work. It's the only one that carries the MSHA/NIOSH approval label. This approval label is one identifying feature of a rescue canister. An easier way to identify the rescue canister is by its silver color.

The absorbent chemical inside the approved rescue canister is lithium hydroxide. This chemical is used in the rescue canister because it's lighter in weight and a more effective absorbent than soda lime.

Keep in mind that the chemical reaction going on inside either the training canister or the rescue canister produces heat. The heat is a natural by-product of the chemical process that removes carbon dioxide from the air you exhale.

Note: Heat and how it is removed from the breathing system will be discussed in more detail when you talk about the unit's heat exchanger.

Because lithium hydroxide is a more efficient absorbent than soda lime and does not contain water, the chemical reaction inside the rescue canister produces more heat. As a consequence, the rescue canister itself gets much hotter than the training canister.

Note: Because the rescue canister gets much hotter than the training canister, tell the team to use extra care when removing it from the unit after use.

Because the canister is much hotter, you might also expect the air that you breathe with the rescue canister to be much hotter. That isn't the case. Due to the unique properties of the absorbent chemical lithium hydroxide and the heat exchange surfaces, most of the heat energy produced inside the rescue canister is removed. By the time the air gets to you, it's as cool as the air you breathe when you use the training canister.

Note: It is recommended that a rescue canister not be used if it is more than five years old. Tell the team members they should also not use either type of canister if the portal seals have been removed, or if the seals are torn or otherwise damaged.

The Heat Exchanger

Visual: Point out the heat exchanger on an apparatus and/or refer again to "Visual 9" for a picture of this part. (You may also wish to refer again to "Visual 2" to trace the flow of air from the canister and through the heat exchanger.)

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Earlier we said that the chemical reaction taking place in the canister produces heat. This heat expends itself in several ways. Some of it heats the canister's metal exterior, some of it heats up the air you breathe, and some of it is transmitted away from you through the grill on the unit's cover. There is also a part inside the unit that's specially designed to eliminate some of the heat produced in the canister–the heat exchanger.

The heat exchanger is a cylindrical bundle of hollow tubes located on the right (or "exit") side of the CO_2 scrubbing canister.

The heat exchanger works on a principle known as conduction to cool the purified air after it comes out of the scrubbing canister.

In order to pass through the heat exchanger's hollow tubes, the air must break up into several small channels. Splitting the air up like this exposes it to more surface area, allowing it to cool off naturally. The metal in the hollow tubes also conducts heat away from the air. Once the heat is outside the heat exchanger, it can eventually rise up and out through the grill on the unit's cover.

The Mixing Chamber

Visual: Point out the mixing chamber on an apparatus and/or refer again to "Visual 9" for a picture of this part.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Once the purified air passes through the heat exchanger, it goes into a hollow metal chamber known as the "mixing chamber." Here, the air mixes with fresh oxygen which comes from the regulator by way of a small hose known as the constant flow hose.

Visual: Point out the constant flow hose on an apparatus and/or refer again to "Visual 9" for a picture of the hose.

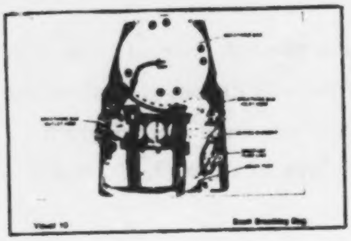
Use this visual as an overhead transparency, chalkboard sketch, or handout.

Note: Remind the team that pressing the bypass button "bypasses" the regulator. (When the bypass is in use, oxygen travels directly from the cylinder to the mixing chamber via another route: The bypass tube.) Point out the bypass line on Visual 9.

The Breathing Bag

Visual: Point out the breathing bag on an apparatus and/or refer to "Visual 10" for a picture of this part and its relationship to other parts in the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Once the air is purified and mixed with fresh oxygen, it moves from the mixing chamber into the breathing bag inlet hose and then on into the breathing bag.

The breathing bag is the large round metal part of the apparatus located inside the top half of the unit's shell above the CO_2 scrubbing canister. It can hold about 5½ liters (or about 5.8 quarts) of oxygen-enriched air.

Air entering the breathing bag is cooled further. The breathing bag also acts as a reservoir, holding oxygen-enriched air until you need to use it.

Visual: Point out the parts of the breathing bag on an apparatus as you discuss them and/or refer to "Visual 11" for a picture of them.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Note: You may wish to point out that (as a design feature) the air in the bag is contained in the bottom next to the back of the apparatus so that penetration of a sharp object into the top does not mean penetration of the breathing bag.

Actually, this breathing bag isn't a "bag" in the traditional sense of the word. It's more like a large round metal container joined in the middle by a metal ring called a "clamp screw ring."

Inside the breathing bag is an aluminum disc with rubber sides. This is the diaphragm.

Demonstration: Demonstrate how to take apart and put together the breathing bag as you discuss it here.

To get to the diaphragm, you must remove the top half of the breathing bag's metal cover. First, loosen the clamp screw ring by unscrewing the clamp screw located on the left side of the bag. Once the screw is loose, slide the ring up over the breathing bag and take it off. Then take off the top half of the breathing bag. You'll see the diaphragm resting inside the bottom half of the breathing bag cover. Pull it out gently so you can examine it more closely.

Notice that there are retaining clips inside the breathing bag inlet and outlet connections in the bottom of the cover. These clips help keep the sides of the diaphragm from pushing out into the hoses.

When you inhale, air leaves the bag through the breathing bag outlet hose on the left side, and the diaphragm begins to collapse against the bottom of the breathing bag cover. Oxygen-enriched air then enters the bag through the breathing bag inlet hose on the right, causing the diaphragm to inflate and move up against the top of the cover.

Note: Point out that the outlet hose connects to the inhalation hose and the inlet hose indirectly connects to the exhalation hose.

Here's how to put the breathing bag back together: When you put the diaphragm back inside the bottom of the cover, make sure that the concave (recessed, or pushed in) center of the aluminum disc faces up. Place the rubber lip of the diaphragm (known as the "bead") over the rim of the bottom cover. Be sure there are no gaps in the connection between the metal shell and the bead.

Note: This is tricky. It's very important to get the bead joined to the shell rim so that air can't leak out of the bag. Tell the team members they may need another person—or even two—to help them with this until they've had some practice. An alternative method if to use masking tape to hold the bead in place on the rim. Remove the tape after you install the clamp ring but before you tighten the clamp screw.

Once the bead is completely over the rim and there are no gaps, you may replace the top half of the breathing bag cover. Make sure that the arrow on the bottom of the cover (left side) matches up with the arrow on the top of the cover.

Then push down on the cover, slide the clamp ring over it, and tighten the clamp screw.

The Demand Valve

Visual: Point out the demand valve on an apparatus and/or refer to "Visual 12" for a picture of this part.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Remember that oxygen normally flows into the breathing bag at a "constant flow" of 1.5 liters per minute. This is usually more than enough oxygen to meet your needs. But if you're working extremely hard, you may need more oxygen. When this happens, a demand valve built into the unit's breathing bag responds by letting in more oxygen as you need it or "on demand."

The demand valve is located inside the bottom half of the breathing bag shell. Here's how it works: Remember that when you inhale, the diaphragm collapses. When you've used almost all the air in the bag (or "breathed down the bag"), the center of the diaphragm moves down and pushes against the metal demand valve lever. This activates a plunger inside the demand valve which, in turn, opens the demand valve line allowing more oxygen to flow into the bag.

Visual: Point out the demand line on an apparatus and/or refer again to "Visual 9" for a picture of this part.

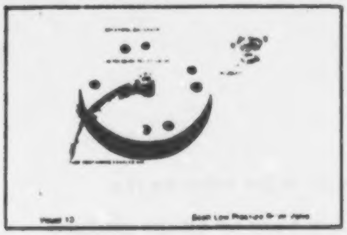
Use this visual as an overhead transparency, chalkboard sketch, or handout.

As this additional oxygen flows into the breathing bag, the diaphragm inflates, moving up and away from the demand valve lever so that it closes automatically.

The Low Pressure Relief Valve

Visual: Point out the low pressure relief valve on an apparatus and/or refer to "Visual 13" for a picture of this part.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



In some cases, such as when you're not working very hard or when you're resting, you'll find you won't need as much oxygen as the 1.5 liters per minute your unit provides. When this happens, the breathing bag becomes overinflated, and a valve known as the low pressure relief valve responds by letting some of the excess pressure out of the system.

The low pressure relief valve is inside the small black box mounted on top of the breathing bag. The opposite end of the clear tube extending from it connects into the unit's breathing system near the exhalation connection slightly upstream of the CO_2 scrubbing canister.

Note: The clear tube also connects to the relief valve shutoff switch on the back of the unit. You'll be talking about this switch next in the lecture.

Due to the point at which it connects into the unit's breathing system, the tube holds some of your exhaled air that has not been scrubbed. It is this expendable unpurified air, rather than the more precious oxygen enriched air, that's let out of the system when the relief valve operates.

Visual: Point out the plunger inside the breathing bag on an apparatus and/or refer again to "Visual 13" for a picture of this part.

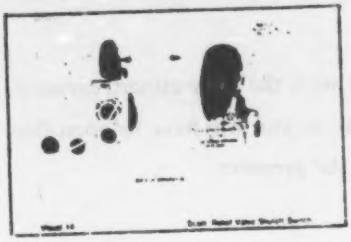
Use this visual as an overhead transparency, chalkboard sketch, or handout.

Here's how the low pressure relief valve works: Remember that when you don't use up all the purified air in the breathing bag, it becomes overinflated. This causes the center of the diaphragm to move up and push against the mushroom-shaped plunger on the top of the breathing bag. This opens the valve, allowing air to escape from the tube. As the pressure inside the bag decreases, the diaphragm begins to move down and away from the top of the bag, and the valve closes automatically. The air that escapes from the tube eventually moves out of the apparatus through the grill in the cover.

Relief Valve Shutoff Switch

Visual: Point out the relief valve shutoff switch on an apparatus and/or refer to "Visual 14" for a picture of this switch.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



On the back of your apparatus, just above where the hoses come in, is a hand-operated switch. This is the relief valve shutoff switch.

Note: The clear tube extending from the top of the breathing bag connects this switch to the relief valve inside the unit.

Normally, you leave this switch in the flat or "open" position so your relief valve can automatically vent excess air from the system as needed. But if your relief valve sticks open or otherwise fails to work properly, you need a backup device to keep the valve from letting too much pressure out of the system.

This is what the relief valve shutoff switch does.

Demonstration: Show the team how to operate this switch as you talk about it.

If your relief valve sticks open and continuously vents air to the outside, simply reach behind you and flip the relief valve shutoff switch up so that it's in the closed position.

Closing the switch doesn't actually "turn off" the relief valve as you might expect. Instead, it just keeps exhaled air from entering the clear tube that extends from the valve. With no air in the tube, the relief valve can continue to operate, but no air can be vented to the outside.

You must remember that with the valve closed, pressure might build up in the system, so you will have to open this valve periodically to relieve the pressure.

The Facepiece

Note: Two facepieces are approved for use with the Scott 4-hour Rescue Pak–the Scottoramic (Scott) Facepiece, and the Panorama Nova (Nova) Facepiece. One state, however, permits use of only the Nova facepiece at this time. The following section contains information on both facepieces. Use the information that pertains to the facepiece your team uses.

The Scottoramic Facepiece

Visual: Display a facepiece as you talk about it and/or refer to "Visual 15" for a picture of the Scottoramic Facepiece.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Your Scottoramic facepiece is made of molded rubber and it is designed so that when its five-strap harness is properly adjusted, it will form a snug, airtight fit against your face. The facepiece also has a neckstrap that you can put around your neck to support the mask when you're not wearing it.

The mask's single viewing lens is made of durable impact-resistant plastic, and the lens is easily replaced if it gets scratched, cracked, or otherwise damaged.

Note: To replace the facepiece lens, first remove the old one by prying off the 15 metal clips that surround it. Then lift out the lens. Align center marks on the new lens with top and bottom center lines marked on the facepiece. Fit the lens into the bottom groove of the rubber and replace the clips.

There are two threaded fittings on the bottom of the mask, mounted one behind the other. These connect up to your breathing hoses. The front fitting connects to the inhalation hose and the back fitting connects to the exhalation hose. The two connections are slightly different in size so it's impossible to interchange them.

Inside the facepiece is a flexible rubber sealing edge that helps form an effective barrier against smoke and gases. The nosecup inside the mask is designed to help channel the inhaled and exhaled air as it travels to and from your mouth.

The nosecup is attached to the facepiece by a single metal snap. It is easily removed for maintenance purposes.

Demonstration: Show the team members how to remove the nose cup as you discuss it.

Note: Scott communication equipment may also be used with your Scottoramic facepiece. Mention this equipment if your team uses it.

Your Scott facepiece is also equipped with check valves designed to keep air traveling in a one-way closed circuit. A valve in the inhalation connection lets air flow only toward you. A valve in the exhalation connection lets air flow only away from you. Both valves block or "check" air moving in the opposite direction.

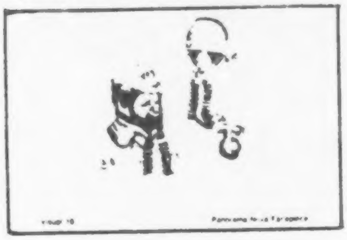
When you breathe out, your exhaled air travels down into the nosecup, through the exhalation check valve and into the exhalation hose. Inhaled air goes up the inhalation hose, through a check valve, and into the facepiece outside the nosecup. The air then enters the nosecup after passing through two more check valves on either side of the nosecup.

The facepiece is designed so that your inhaled air enters the facepiece outside the nosecup so that the inhaled air (which is cooler than the exhaled air) will pass in front of the lens and help keep it from fogging.

The Panorama Nova Facepiece

Visual: Display a facepiece as you discuss it and/or refer to "Visual 16" for a picture of the Panorama Nova Facepiece.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Your Panorama Nova facepiece is made of molded rubber and it is designed so that when its five-strap harness is properly adjusted, it will form a snug, airtight fit against your face. The facepiece also has a neckstrap that you can put around your neck to support the facepiece when you aren't wearing it. You can shorten the neckstrap by attaching the button on the strap to the small buttonhole on the center head strap.

The lens is made of impact-resistant plastic, and it's designed to give you ninety percent peripheral (side) vision, so you don't have to turn your head too far to either side in order to see.

Your mask is equipped with a speaking diaphragm made of aluminized mylar. When you talk, this thin flexible disc vibrates in order to transmit your voice to the outside.

Note: Scott communication equipment may also be used with the Panorama Nova Mask. Mention this equipment if your team uses it.

Nova ZS note: If their masks are equipped with manually operated wipers, be sure to tell the team that the wipers must be kept lubricated with antifog solution at all times (even during storage) to keep the leather from drying out. Demonstrate the proper procedure for operating the wiper: Some models have one knob and some have two knobs. If there are two knobs, turn one wiper knob to bring the wiper from the top of the lens, and then turn the other knob. Reverse that procedure to bring the wiper to the top rest position.

There is a single metal coupling on the bottom of the mask with two threaded fittings on it. These fittings attach to your breathing hoses. When you're wearing the facepiece, the inhalation hose will be on your left and the exhalation hose will be on your right. The two connections are slightly different in size so its impossible to connect the inhalation hose to the exhalation connection and vice versa.

Note: The metal coupling attaches to the facepiece with a single metal screw.

If you look closely at the inside of the metal coupling for the breathing hoses, you'll notice it has a divider ridge or "dam" built into it. This dam helps separate inhaled and exhaled air as it passes between you and the breathing hoses. A nosecup built into the facepiece also helps channel inhaled and exhaled air.

The facepiece has two sealing edges that form an effective seal against smoke and gases. The hoses you use with your Panorama Nova facepiece are equipped with rubber valves, known as "check" valves, designed to keep air traveling in a one-way closed circuit. These valves are located below the saliva trap. The inhalation valve lets air flow only toward you. The exhalation valve lets it flow only away from you. Both valves block or "check" air moving in the opposite direction.

When you breathe out, your exhaled air travels down into the nosecup and into the exhalation hose where it passes through the exhalation check valve. Inhaled air travels up the inhalation hose, through the inhalation check valve, into the nosepiece, and on into your mouth.

Breathing Hoses

Note: Either approved facepiece (Scott or Nova) uses the Scott hoses described in this section. The only difference is that if you use the Nova facepiece, your hoses will be equipped with a Scott saliva trap, and inhalation and exhalation check valves.

The breathing hoses that connect your facepiece to the unit are made of strong corrugated rubber. The snaphook in the center of them may be clipped to the harness in order to relieve the facepiece of some of the hose's weight.

If you look inside the threaded connections on either end of the hoses, you'll see that the rubber ends of the hoses themselves serve as sealing edges to help insure an airtight fit with the apparatus and the facepiece. You don't need to use gaskets with these hoses. If the sealing edge gets worn, simply clip off the worn part of the hose and move the corrugated rubber up one notch to form a new sealing edge.

The inhalation hose coming from your facepiece connects to the bottom hose coupling on the Back-Pak Shell. The exhalation hose connects to the top coupling. Like the facepiece connections, it's impossible to get the inhalation and exhalation connections attached to the unit the wrong way because they fit together only if they're put on the right way.

Nova Facepiece note: (Saliva trap) If your team uses the Panorama Nova Facepiece, their breathing hoses will be equipped with a saliva trap. This is the small round black container attached to the inhalation hose. Point out the saliva trap to the team and tell them it is designed to trap and hold moisture that settles out of the air they breathe. Also tell them why the trap is attached to the inhalation hose: It must be on the lowest point so the moisture will settle there.

READEX FICHE

The Drain Tube

Visual: Point out the drain tube on an apparatus and/or refer back to "Visual 10" for a picture of this part.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Moisture tends to settle out of the air you breathe in the Scott's closed-circuit system. Your unit is equipped with a drain tube designed to catch and hold this moisture.

Nova Facepiece note: Breathing hoses used with this facepiece are equipped with a saliva trap. The drain tube is still important, as it acts as a backup for the saliva trap.

The drain tube is simply a clear plastic tube with a threaded plug on one end for emptying it. It rests horizontally against the oxygen cylinder inside the Back-Pak Shell.

The drain tube connects into the breathing system slightly upstream of the CO_2 scrubbing canister.

Note: If you use the apparatus in the prone position for a long period of time, moisture may accumulate in the breathing tubes. Tell the team that this moisture may be removed by positioning the unit and hoses vertically so that the moisture will flow into the drain tube.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. What is the purpose of the frangible disc on the oxygen cylinder valve assembly?

   (Answer: It provides for the safe escape of oxygen without rupturing the cylinder if the pressure gets too high due to heat.)

2. What does the bypass valve do?

   (Answer: Bypasses the regulator to send you a burst of high pressure oxygen in case the normal supply route fails to deliver enough.)

3. What should you do if your pressure gauge line rips?

   (Answer: Block the path of oxygen going to the remote pressure gauge by turning the remote gauge shutoff valve clockwise (off). To find out how much oxygen you have left, use the cylinder gauge inside the unit. Have a teammate lift the cover and read the gauge.)

4. What does the low pressure relief valve do?

   (Answer: Automatically releases excess air pressure in the system if you don't use up all that is supplied. This pressure, in the form of exhaled air, is vented to the outside.)

5. What happens in the CO_2 scrubbing canister?

(Answer: The chemical in the canister absorbs the carbon dioxide from exhaled air as it passes through allowing only purified air to emerge from the exit portal. The chemical reaction inside the canister produces heat which heats up the canister and the air you breathe.)

6. What is the purpose of the heat exchanger?

(Answer: It cools the purified air coming out of the CO_2 scrubbing canister.)

7. When you inhale, what happens to the breathing bag inside the unit?

(Answer: The bag begins to collapse and air leaves the breathing bag through the breathing bag outlet hose on the left side. This outlet hose connects to the inhalation hose on the outside of the apparatus.)

EMERGENCY BACK-UP PARTS AND PROCEDURES

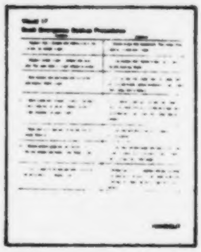
Remember that under normal circumstances your unit works entirely automatically so you can concentrate on your work. However, your apparatus is also equipped with several backup devices designed to be used in the event of an emergency. These are the manual controls on the back of the unit and the cylinder valve inside it.

Hopefully, you'll never have to use these backup safety devices, but it's very important for you to learn how and when to use them. Then if an emergency situation does occur, you'll be ready for it. Knowing how to use these safety devices could very well save your life.

Let's take a look now at some emergency situations that could occur and how you can remedy them.

Visual: Refer to "Visual 17" as you discuss this. Point out each emergency situation/problem and its corresponding solution as you discuss it in the lecture.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



One of the backup safety devices on your unit is the bypass valve. You already know that you can use the bypass valve if you're working so hard that you're using more oxygen than the 1.5 liters per minute your unit provides. But there may also be a time when your regulator fails to work properly, or your demand valve malfunctions so that you don't get enough oxygen-enriched air. The best way to correct this is to bypass the malfunctioning parts by "short-circuiting" the oxygen route. To do this, simply press the bypass valve to get the air you need. Then release it and press it again when you feel the need for more air.

Note: Remind the team members to use the bypass valve sparingly.

The opposite could happen too—you could begin getting too much oxygen because your regulator malfunctions and starts dumping oxygen into the system too fast or the demand valve sticks open. If this happens, you'll feel a great deal of pressure inside your facepiece and will probably hear the constant flow of oxygen.

This situation is potentially very dangerous because you'll be using up your oxygen supply much too fast. So what you'll want to do is to keep oxygen from flowing into the demand valve or regulator altogether, and use an alternate route to bypass the malfunctioning elements and get the oxygen you need.

To keep oxygen from pouring into the system, turn off the mainline valve. With the mainline valve off, you can simply use up what's in the breathing bag or "breathe down the bag." Then when you feel the need for more oxygen, press the bypass to fill the bag, breathe it down, and repeat the procedure.

It's unlikely that this will ever happen, but if your main-line valve and your bypass valve stick in the open position, you've still got an alternate way to control the flow of oxygen—by using the cylinder valve inside the unit.

Have a team member remove the cover of your unit for you, turn off the cylinder valve, and breathe down the bag. Then use the cylinder valve as you would the bypass, opening it for just a moment, then closing it, to get the oxygen you need.

Remember that if your alarm rings for more than a minute, you've only got about fifteen minute's worth of oxygen left. If you think it's going to take more time than that to get to fresh air, you'll want to conserve every last bit of oxygen you've got left.

In a case like this, you'll even want to save the oxygen that's activating your warning alarm. So open the unit's cover and close the cylinder valve. This shuts off the alarm. Then breathe down the bag.

When you need oxygen again, open the cylinder valve, press the bypass, then close the cylinder valve.

Remember that if your relief valve sticks open and continuously vents air to the outside, you can remedy the problem by closing the relief valve shutoff on the back of the unit. To close it, pull the switch up.

If your gauge line gets ripped or damaged and begins leaking oxygen, remember to close the gauge shutoff on the back of your unit. If necessary, you can still keep track of how much oxygen you have by opening the cover and reading the cylinder gauge.

If you're doing actual rescue work, there's always the remote possibility that you could become trapped in the mine. Your Scott 4-hour Rescue-Pak is equipped to handle an emergency like this.

If you are trapped, you'll want to slow down the rate at which you use oxygen. One way to do that is to remain quiet until help arrives. Turn off your mainline valve and flip your pressure relief valve into the "up" or "closed" position. Breathe down the bag and, as you need it, use the bypass. Keep breathing from the bag and use the bypass only as you need more oxygen. This technique can extend the oxygen supply up to seven times.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. If you are not getting enough oxygen because your demand valve or regulator is not functioning properly, what should you do?

   (Answer: Use your bypass valve to get oxygen when you feel you need it.)

2. What should you do if you are getting too much oxygen because the regulator of the demand valve is dumping too much oxygen into the system?

   (Answer: Turn off the mainline valve. Use what's in the breathing bag and then press the bypass valve to refill the breathing bag.)

3. If you become trapped in the mine, how can you slow down your consumption of oxygen?

(Answer: Stay quiet. Turn off the mainline valve and the pressure relief valve. Use up the air in the bag and then use the bypass. Repeat this process, breathing down the bag and using the bypass when necessary.

PUTTING ON THE APPARATUS

Objective 3: The team members will put on and take off the apparatus correctly and check it for proper functioning.

Note: Testing the unit is covered in the "Bench Duties" section of this module.

Once the unit has been tested, it takes only a few minutes to put it on and get under oxygen.

Before you put on the apparatus, remove the cover and check to make sure these tasks were performed during preparing and testing the apparatus: You should have a full oxygen cylinder and a fresh, properly attached CO_2 scrubbing canister. Make sure the canister is the right type for the work you're doing–a white canister for training or a silver canister for actual rescue work.

During the testing procedure you should also have checked to make sure the warning alarm was working and turned on the oxygen supply by opening the cylinder valve inside the unit. Make sure the drain tube is in the proper place and it's cap is on. Replace the cover. Now check to make sure your relief valve shutoff switch is in the down or flat position.

Once you're sure all of these things have been done, you're ready to prepare the facepiece and put on the apparatus.

Demonstration: As you discuss this procedure, put on the apparatus yourself or have a team member put it on. Make sure that you cover each step thoroughly.

Note: Do not use an anti-fog solution that contains alcohol. Alcohol can cause premature aging and cracking of the facepiece lens. You should use only the approved anti-fog solution.

First, check the facepiece and breathing hoses visually. Then coat the inside of the facepiece lens with an anti-fog solution. If your mask is equipped with a wiper, make sure it is well-lubricated. Now attach the hoses to your facepiece and put on the facepiece to check that your inhalation and exhalation valves are functioning properly.

When putting on the facepiece, first pull the head harness away from the mask and fully extend the straps. Then put your chin into the bottom of the facepiece and pull the harness down over your head, making sure the harness web is straight.

Tighten the straps by pulling back on each pair at the same time. Start at the bottom and work your way up. It is important to properly stroke down the harness for a good fit.

If it's necessary to do so, tighten the top strap last. You usually adjust the top strap to fit your head and then leave it that way.

To test the inhalation valve, seal off the end of the exhalation hose and exhale into the facepiece. No air should leak out through the inhalation valve. Now seal off the end of the inhalation hose and try to inhale. No air should enter the facepiece through the exhalation hose.

Remove the facepiece. Attach hoses to the apparatus and to the "D" ring on the harness.

Then set the apparatus upright on the edge of a table or workbench so the back of it (harness side) faces you. Straighten out the harness straps and extend the right and left shoulder straps fully so you'll be able to get your arms into them.

Then turn around so that your back faces the unit and slide your left arm through the shoulder strap. Pull the right shoulder strap over your shoulder and swing the apparatus onto your back.

Now hook up the chest strap, and adjust it to fit. Adjust the right and left shoulder straps by pulling down on the ends of them until the apparatus rests comfortably on your back. Then buckle the waist strap and adjust it to fit.

Suspend the facepiece from your neck by putting the strap over your head.

Next, turn on the apparatus by fully opening the main-line valve–the yellow knob on the back of the unit. Now you're ready to put on the facepiece.

First pull the head harness away from the inside of the mask and make sure the straps are fully extended. Then put your chin into the bottom of the facepiece and pull the harness down over your head, making sure the harness web is straight.

Now tighten the straps and stroke down the head harness for a good fit.

Note: Have the team members make sure there's no hair trapped between their face and the facepiece seal. This should be pushed out of the way as it could cause a break in the face-to-facepiece seal.

The facepiece should be comfortable but secure, and have a good face-to-facepiece seal so it won't leak around the edges. To test this seal, squeeze both breathing hoses shut with your hands. Then inhale and exhale forcefully several times. If the seal is good, air shouldn't leak into the facepiece when you inhale, and it should leak out only when you exhale with great force.

Once you know the facepiece seal is good, there are a few routine checks you must make before you begin training or rescue work. Remove its protective cap and check the remote pressure gauge to make sure you have a fully charged oxygen cylinder. If you don't get a gauge reading, chances are your remote gauge valve is off, so turn it on at this point. Remember that the remote pressure gauge valve is on the back of your apparatus below the mainline valve. Once you're sure you have a full cylinder, replace the cap on the gauge.

Note: Remind the team members that they should never overlook checking the pressure on the remote gauge at this point, even if they checked it earlier when they prepared the unit for use.

Check once more to make sure your relief valve shutoff is in the "open" position (down or flat.) Finally, check your bypass valve by pressing in on the recessed button and listening for the sound of air rushing into the breathing bag. Then release the button. If everything checks out O.K., you're ready to go.

Note: At this point, the team captain will check each team member's apparatus. Then the captain will be checked by another team member.

TAKING OFF THE APPARATUS

Taking the apparatus off after your training session or rescue work is not something to be done haphazardly. Here's how to do it properly:

Demonstration: Demonstrate how to properly take off the apparatus as you discuss it below.

First, remove the facepiece and let it hang from your neck by the neckstrap. Now you can reach back and turn off the mainline valve.

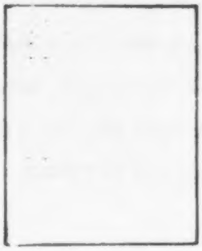
If you can, get a teammate to help out by disconnecting the breathing hoses from the apparatus.

Now unfasten the waist and chest belts, slide the apparatus down your left arm, and take the apparatus off. Then slip the facepiece neckstrap over your head and take it off.

If you didn't do it earlier, disconnect the hoses from the apparatus. Then disconnect the hoses from the facepiece.

Lay the apparatus down flat on a bench or table with the cover facing up. Remove the cover, turn off the cylinder valve, and replace the cover.

Demonstration check: Have the team members put on and take off the apparatus. Use copies of the *Demonstration Check 1 – Putting On and Taking Off the Scott* form provided at the back of this module to check each team member's performance. Review results with each team member.



WEARING THE APPARATUS

Objective 4: The team members will wear the Scott apparatus and define its limitations when worn.

Once you've put on the apparatus and made the checks we discussed earlier, you're ready for your practice session or for actual rescue work. Your unit will work entirely automatically to supply you with oxygen.

With the exception of checking your pressure gauge every now and then, normally you'll be free to concentrate on the work at hand.

Note: Remind the team members that they may also need to use the unit's bypass valve if they're working unusually hard.

Of course, your captain will stop the team periodically and check to see how each member is doing. During this check, the captain will also check your pressure gauge reading, make sure that your relief valve shutoff is open and visually inspect your wearing harness and facepiece.

Limitations

Like any other apparatus, your Scott 4-hour apparatus has limitations. That is, there are things it cannot do and special factors you should take into consideration when you wear it.

We talked generally, in the Introduction to Self-Contained Breathing Apparatus module, about some of the limitations placed on you when you wear an apparatus.

Note: At this point you may wish to review the general limitations from the *Introduction to Self-Contained Breathing Apparatus* Module (MSHA 2003).

We'll look now at specific limitations of the Scott. You should be thinking about these limitations, and learn to deal with them during training sessions. When you're working on a rescue operation, you're going to want to work as naturally and efficiently as possible.

Weight and Size of Apparatus

The weight and size of the apparatus are two things to be considered when you wear the Scott. Fully charged and assembled, the apparatus weighs 35 pounds. It is 24 inches long, 17 inches wide, and 7½ inches deep.

While you're wearing the apparatus, you'll have to think about keeping the weight distribution even. Remember to bend your knees rather than your back when you change position or lift something. And keep in mind that you won't be able to fit into tight places as easily as if you weren't wearing the unit.

Time Limit, Work Rate and Breathing Rate

Any breathing apparatus you use will limit the time you'll have to do your work. The Scott Rescue-Pak is approved for four-hour use. Of course, you should remember that if you work unusually hard you'll use up oxygen at a faster than normal rate. Excitement, fear, and other emotional states also cause you to breathe more quickly and consequently use up your oxygen faster than you do when you're calm.

Another thing to take into consideration when you wear the apparatus is that the air you breathe through it may get warm or hot and have a lot of moisture in it.

Remember that the buildup of heat within the unit is produced by the chemical reaction going on inside the CO_2 scrubbing canister. Some of this heat is removed from the air when it travels through the heat exchanger, and some escapes through the grill in the unit's cover. But some of it unavoidably remains in the system, increasing the temperature of the air you breathe.

Breathing this hot air laden with moisture created by the condensation of water in your breath can cause additional stress, especially when you're working extremely hard.

Note: You might wish to mention that the "extra stress" this creates is something like working on a hot, humid day vs. working on a cool, dry one.

The heat and moisture produced within the unit can also cause the facepiece to fog, making it difficult for you to see. This is why you should always use an anti-fog solution on the lens before you put the facepiece on.

Note: If the team members use the facepiece equipped with wipers, remind them that they can also use the wipers to clear the lenses.

Temperature Range

Under the "limitations" heading on your unit's approval label, you'll find its rating for cold weather use. This is 32° F (0° C). This means that your unit is approved for use at temperatures above freezing.

Note: The unit will work at lower temperatures when the heat generated during use is sufficient to prevent the water inside the system from freezing.

Note: Because of the location of the hose connections on the Scottoramic facepiece and the speaking diaphragm on the Panorama Nova, team members may not be able to bend their heads fully down. This could lift the facepiece away from their chins, breaking the face-to-facepiece seal.

The Scottoramic facepiece can be modified to be worn with corrective lenses. The Panorama Nova cannot.

Mention any other limitations of the Scott that apply to your own rescue and recovery operations.

Be thinking about the limitations of your apparatus, and learn to deal with them during training sessions. Then you'll be sure of being able to work as efficiently as possible during an actual emergency.

Wearing Schedule

Note: In the back of this module you'll find a *Suggested Wearing Schedule* for the apparatus. It presents a three-session practice schedule for wearing the apparatus. It is recommended that these practice sessions be conducted after you've presented the training material contained in the module.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. **Under what circumstances will you use up your oxygen supply faster than normal?**
   (Answer: If you're working extremely hard, or if you become excited or afraid.)
2. **What produces the heat that increases the temperature of the air you breathe?**
   (Answer: The chemical reaction that scrubs your exhaled air as it travels through the scrubbing canister. Also, your warm exhaled breath.)

3. What things must be taken into consideration due to the size and weight of your apparatus?

(Answer: Keeping the weight distributed evenly, bending your knees instead of your back, and fitting into tight places.)

4. Heat and moisture produced within the unit can produce what two problems?

(Answer: It causes extra stress, especially if you're working hard, and it causes the facepiece to fog, making it difficult to see.)

Objective 5: The team members will perform required and recommended testing and maintenance of the Scott Rescue-Pak.

Note: The rest of this module is about apparatus testing and maintenance. Since testing and maintenance programs differ from one mine to another, this section is designed so that you can adapt it to fit your own training needs. Simply use the parts that fit your program and leave out those that don't.

BENCH DUTIES

When you're under oxygen, every move you make depends on the smooth operation of your breathing apparatus. And your team's performance level can only match that of each individual member–including you.

This is why it's impossible to over-emphasize the importance of keeping your apparatus in top condition. You can keep it operating properly only by testing and maintaining it on a regular basis.

Note: You may wish to point out that the term "bench duties" is often used in reference to testing and maintenance procedures because the tests are often performed with the units resting on a table or "bench."

Cleaning and Disinfecting the Apparatus

To keep your apparatus in good condition, you must clean and disinfect it after each and every use. Before you do this, remove the CO_2 scrubbing canister, the oxygen cylinder, and all parts exposed to the breathing circuit.

Disassembling the Apparatus

Note: At this point, breathing hoses should be disconnected from the apparatus and the facepiece, and the cylinder valve should be turned off.

Demonstration: Demonstrate the following procedures as you describe them. Either demonstrate them yourself or have a team member do it.

To disassemble the apparatus, begin by laying the unit down on a bench or table. Then remove the cover.

Next, remove the CO_2 scrubbing canister by unhooking the two elastic straps from the metal plate underneath it. Then unscrew the clamp screw knobs at either end of the canister. Dispose of the canister immediately to make sure no one else reuses it accidentally.

Note: Warn the team members that the canister will be very hot, so they should take great care when removing it. If they are using a rescue (silver) canister, which gets much hotter than the training canister, they should use a glove or other covering to protect their hands.

The next step is to remove the cylinder and the valve assembly. But before you do this, there are a few checks you should make. First make sure the cylinder valve is off. Now check your remote gauge to see if there's pressure indicated on it. If you do get a gauge reading, that means there is air trapped between the cylinder valve and the remote gauge shutoff valve. Leaving this air trapped between the two valves will make it very difficult to remove the attachment bolt. To get rid of this air, simply press the bypass until your remote gauge reads "0."

In the event that you forget to release the pressure trapped between the two valves, the pressure will "bleed" out automatically from a port on the side of the regulator box. This way, however, the air escapes very slowly.

Never try to remove the cylinder and valve assembly while there is air escaping from this vent. The air trapped behind the bolt could push it out at you with great force, possibly causing injury.

Once the remote pressure gauge reads "0" and there's no air escaping from the vent, you're ready to remove the cylinder and valve assembly. Unhook the elasticized straps that hold the cylinder in place, unscrew the attachment bolt, and move the cylinder and valve assembly away from the manifold assembly and out of the shell.

Note: Remind the team that they will have to turn the cylinder slightly counterclockwise to remove it.

Draining the Unit

The next step is to drain any moisture that has collected in the apparatus. Most of the moisture is collected in the breathing bag and it must be drained even if there appears to be no moisture in the drain tube.

When you drain this moisture from the unit, it flows from the breathing bag, through the breathing bag outlet hose, and out through the drain tube. So before you drain the unit, be sure to disconnect the breathing bag inlet hose (either from the breathing bag or from the mixing chamber) so that the moisture won't be able to flow back toward the manifold. Also plug the inhalation hose connection so that water can't run out of it.

Visual: Demonstrate this procedure with an apparatus and/or refer to "Visual 18" as you discuss it.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Then pull the drain tube out from under the elasticized band that holds it against the cylinder. Remove the threaded plug from the end of the tube, and let the end hang down into a pail or other container.

Now hold the apparatus upright and tilt it up on one corner so that moisture will drain from the breathing bag into the outlet hose, into the drain tube, and then out into the pail.

When you've finished, dispose of the moisture you've collected in the pail, replace the threaded plug on the drain tube, and put the tube back inside the apparatus.

Washing, Rinsing, and Drying

Now you're ready to clean and disinfect the breathing hoses, facepiece, and breathing bag. It's important to clean these parts of the system because they're the ones that come into contact with your breathing air.

First, run clear water through the breathing hoses to rinse out any saliva that may be caught in the corrugations of the hoses.

Note: If the team uses hoses equipped with saliva traps, have them empty and rinse the traps at this point.

Now clean the hoses and the facepiece with a 5 to 10 percent solution of sodium carbonate and water. (This is 1 part sodium carbonate to 10 or 20 parts water.)

Note: Sodium carbonate is commonly known as "sal soda."

Scrub the parts gently with a soft cloth or brush, and when they're clean, rinse the hoses and facepiece with clean, lukewarm water.

Now get the breathing bag ready for disinfecting: Prepare a 50 percent solution of water and ethyl alcohol (half water and half alcohol). Then plug the breathing bag outlet hose.

Note: If possible, it's best to plug the outlet hose at the inhalation connection on the back of the unit so you can let the disinfecting solution run into the hose.

Disconnect the inlet hose from the mixing chamber and pour the alcohol-and-water solution into the breathing bag through the inlet hose. Slosh this solution around inside the breathing bag for at least two minutes. Then treat the facepieces and breathing hoses with the disinfecting solution.

Visual: Demonstrate this procedure with an apparatus and/or refer again to "Visual 18" as you discuss this.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

To get the disinfectant out of the breathing bag, you'll drain the unit the same as you do to get rid of moisture that collects in the apparatus while you're wearing it. First, plug the open end of the breathing bag inlet hose so that the solution can't flow back toward the manifold and damage it or other parts. Then tilt the apparatus so that the solution drains out of the drain tube and into the pail.

Rinse the disinfected facepiece and breathing hoses with clear water. Unplug the inlet hose on the breathing bag, flush the bag with water, plug the inlet hose again and tilt the apparatus so the water drains out through the drain tube.

Now be sure to dry all the parts thoroughly. You may hang the facepiece and breathing hoses up to dry in a clean, well ventilated room. You may also use a hair dryer or other device that provides a warm air flow to dry the parts, as long as the air temperature doesn't get above 120° F (49° C).

Reassembling and Storing the Apparatus

When you're sure all the parts of the apparatus are clean and dry, it's time to reassemble the apparatus and get it ready for storage.

Note: All fittings, except the attachment bolt, should be finger-tightened for storage.

First, put a fully charged oxygen cylinder in the apparatus. Before you do this inspect the two "O" rings on the cylinder for signs of wear or damage. When you place the cylinder in the shell, make sure that the washer underneath the valve assembly is in place. Insert the attachment bolt and tighten it with the nut driver. Then bring the elastic straps up over the cylinder and fasten them to the metal plate.

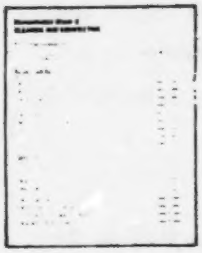
Now put the plastic dust covers back in place on the end plenums. You may store a CO_2 scrubbing canister inside the apparatus, but don't remove the portal seals. Remove them only when you're going to use or test the unit. Place the canister in the shell so that the arrows on it point in the same direction as the ones on the end plenums–from left to right.

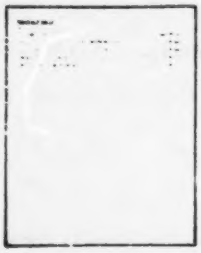
Note: Some teams prefer to store the scrubbing canisters outside the apparatus. If this is the way you do it, be sure to tell the team where and how to store the canisters.

Replace the cover on the shell, and put the Scott apparatus in its carrying case to protect it from dust and dirt. Then store the unit in a convenient place so that it will be ready for immediate use.

Note: 30 *CFR*, Section 49.6(b) requires that apparatus be stored and maintained in a manner that will ensure readiness for immediate use.

Demonstration check: Have each team member remove the exposed parts, disinfect them, and reassemble the apparatus. Use copies of the *Demonstration Check 2–Maintenance* form provided at the back of this module to check each team member's performance.





Oxygen Cylinders

The oxygen you use with your apparatus is pure and it's stored in the cylinders under high pressure. Both of these factors combine to make handling cylinders and using oxygen hazardous unless you take some precautionary measures.

Handling and Storing the Cylinders

For example, it's dangerous to work with oxygen or store it near fire or other sources of ignition (such as lit cigarettes). This is because oxygen "feeds" a fire, causing it to burn with more intensity.

So be sure to keep combustible materials away from the area where you're filling or storing oxygen cylinders. Make sure there are no open flames nearby and make sure you don't smoke in the area–and don't let anyone else smoke either.

Never store or use grease, oil, or other combustible substances near oxygen equipment. Be sure to keep oxygen pumps, connections, hoses, cylinders, and your apparatus clean and free of oil, grease, or other lubricants not approved for use with them.

Make sure that the area where you'll be filling and storing oxygen is well ventilated so that oxygen can't build up in the atmosphere, increasing the chances of having a fire.

Keep in mind that the high pressure inside an oxygen cylinder can cause it to rupture with great force if it's handled roughly or damaged.

Use caution when you handle oxygen cylinders. Take care not to drop them or knock them over. Always lay cylinders on the floor, not on a table.

When you store oxygen cylinders, put them on racks or secure them with chains so they can't fall over. The temperature in the room where they are stored should be about 70° F (21° C).

Finally, if you're transporting cylinders outside the apparatus, be sure to secure them so they can't bump against one another or fall over, and be sure the cylinder valves are tightly closed.

Methods for Filling Oxygen Cylinders

There are two methods of filling oxygen cylinders at a mine site: the cascade system and the high-pressure oxygen pump.

The cascade system can be used to recharge a cylinder when the pressure service rating is 2400 PSI or less.

The high pressure oxygen pump (also called a booster pump) must be used to recharge a cylinder to pressures above 2400 PSI. (However, the oxygen pump may also be used to recharge cylinders that hold 2400 PSI or less.)

Reference: 30 *CFR*, Section 49.6(a)(4) **states that each mine rescue station shall be provided with at least one oxygen pump or a cascading system, compatible with the team's breathing apparatus.**

When fully charged, your Scott Rescue Pak's cylinder has a capacity of 1980 PSI. Either the cascade system or a booster pump may be used to recharge it.

Note: Most mines use the cascade system to recharge the Scott's cylinder.

Note: This module contains *general* information about procedures and precautions for filling oxygen cylinders. If you need to know more about exact procedures for filling cylinders using either the cascade or booster pump system, refer to the mine

rescue handbook: *Mine Rescue Apparatus and Auxiliary Equipment* by Morrow, Demkowicz, and Chastain.

Checks to Make Before Filling Cylinders

Before you fill a cylinder, you should inspect it for damage and check the hydrostatic test date and the pressure service rating.

Note: If you are using an oxygen pump, also check to make sure there's a filter dryer on the gas inlet side of the pump. This keeps dust and moisture out of the pump. Be sure to change or refill this filter regularly.

Before you fill any cylinder, always check it for dents, corrosion, or other signs of damage. A damaged or corroded cylinder could rupture under pressure. Shake it gently and listen for noise made by particles of rust and corrosion. Periodically immerse the cylinder in water to check for bubbles and leaks.

If you find that the cylinder you're about to fill is damaged, don't fill it. Have it hydrostatically tested. Even if the cylinder is not badly damaged, but you're not altogether sure it's safe to use, don't take chances. Hydrostatic testing is the only way to determine the complete condition of the cylinder.

Visual: Point out the following markings on a cylinder and/or refer again to "Visual 4" as you discuss this.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Always be sure to check the pressure service rating and the hydrostatic test date stamped on a cylinder before you fill it.

Remember that the pressure service rating marked on the cylinder is the highest pressure to which it may be filled. In the case of the Scott apparatus, this is 1980 PSI. (It may be written as 1800 plus 10 percent, which also equals 1980 PSI.) Never fill the cylinder beyond the pressure service rating stamped on it.

Remember that the hydrostatic test date indicates when the cylinder is due for its next hydrostatic test. Every cylinder must be hydrostatically tested every five years. So if five or more years have passed since the date stamped on the cylinder, it's due for testing. Don't fill such a cylinder. Have it hydrostatically tested.

Precautions for Filling Oxygen Cylinders

Note: Oxygen cylinder should always be filled slowly.

When you're filling cylinders at the mine site, they should never be completely empty. During training you should always keep at least 500 PSI in them. This small amount of pressure prevents outside air and moisture from getting into the cylinder. You want to keep air and moisture out because they can foul the oxygen or corrode the inside of the cylinder. Corrosion inside the cylinder is particularly hazardous because the corroded particles can be blown into the apparatus when you open the cylinder valve.

If your cylinder gauge reads zero, don't use the cylinder. Have it purged and vacuumed.

Before you connect the cylinder to the source you're using to recharge it, crack the cylinder valve open for just a few seconds and then close it. This blows out dust or moisture that may have gotten inside the valve. Be sure to point the valve away from your face when you do this.

Only use oxygen that conforms to United States Pharmacopoeia medical oxygen standards in the cylinder. Other grades of oxygen could contain impurities or moisture that could affect the operation of your apparatus.

When filling bottles at high pressures they should be placed in a strong container or holder to prevent injury in the event that the bottle busts or explodes.

The temperature in the room where you're filling cylinders should be about 70° F (21° C). If the temperature gets much higher than this, the oxygen in the cylinder will expand. When you check the gauge, the cylinder may then appear to be full, but when it cools off, the oxygen will contract and the cylinder will be less than full. If this is the case, you'll have to add more oxygen to the cylinder, or, in other words, "top if off" to get the cylinder fully recharged.

The reverse can happen if the cylinder is filled in a cool room. At lower temperatures, oxygen contracts. The cylinder may then appear to be full, but when it warms up, the oxygen will expand. This can cause the pressure in the cylinder to rise above the pressure service rating.

Note: The increase in pressure that results in nominal "overpressurization," is allowed for in the design of the cylinder.

Procedure for Filling Scott Oxygen Cylinders

Visual: Display a charging fitting, point out its parts, and show how it is attached to the cylinder as you discuss this and/or refer to "Visual 19" for a picture of the fitting.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Visual 19
Scott Charging Fitting

Packed with your apparatus is a metal part used to connect the unit's oxygen cylinder and valve assembly to the source used to fill the cylinder. This part is known as the "charging fitting."

When you're ready to charge the cylinder, attach the charging fitting to the cylinder and valve assembly by putting the probe into the port on the charging fitting. Then insert the attachment bolt through the hole in the valve assembly and into the threaded fitting provided for it on the charging fitting. This holds the valve assembly and the charging fitting together. Use the nut driver packed with your unit to tighten the attachment bolt.

After you've attached the charging fitting to the valve assembly, you can link the charging fitting to the oxygen source. To do this, simply connect the outlet on the charging fitting to the source outlet and screw the threaded nut on the charging fitting into place over the source outlet. Be sure it's tight.

Now open your cylinder valve by pushing on it gently and rotating it counterclockwise. Then open the source valve and let oxygen flow into the cylinder at a rate not greater than 300 PSI per minute. When your cylinder gauge and source gauge both read 1980 PSI, close the source valve. Then close the cylinder valve.

Note: Charging causes the cylinder to warm up. As the cylinder cools, the pressure will decrease by 100-200 PSI. You can eliminate this by charging the cylinder at a slower rate, or you can simply top off the cylinder after it cools.

Now that your cylinder is fully recharged, your first impulse may be to simply disconnect the charging fitting. But don't do it. First you have to eliminate any oxygen that may be trapped between the two valves. To do this, slowly loosen the connection nut until the trapped oxygen bleeds out through the hole in the nut.

Note: A release valve could be added to the oxygen supply line to relieve any excess pressure.

Once the trapped oxygen is out, disconnect the charging fitting from the source. Then unscrew the attachment bolt and remove the charging fitting from the cylinder and valve assembly.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss correct answers with them so they fully understand the material covered in this section.

1. **Why should you always keep at least 500 PSI in an oxygen cylinder?**

   (Answer: The small amount of pressure keeps out air and moisture, which could foul the oxygen or cause the inside of the cylinder to corrode. Corroded particles could get inside the apparatus.)

2. **What checks should you make before you fill a cylinder?**

   (Answer: Inspect the cylinder for dents, corrosion or other damage. Check the pressure service rating and the hydrostatic test date.)

3. **What are some safety rules to follow in an area where you're filling oxygen cylinders?**

   (Answer: No smoking or open flame. Keep oil, grease and combustible materials away from the area. Make sure the room is well-ventilated and the temperature is about 70° F (21° C).

4. What is the maximum (or highest) pressure to which you may fill your Scott oxygen cylinder?

   (Answer: 1980 PSI. [This is the pressure service rating marked on the cylinder.])

Apparatus Testing

Note: **Depending on how your training program is set up, the team members may or may not be responsible for testing their own apparatus and keeping records. You may leave out information in the next sections that doesn't apply to your program. *However, it's important for all the team members to know what the law says with regard to inspection and recordkeeping.***

As you've seen so far, your Scott Rescue-Pak is made up of a large number of parts. In order for your unit to work efficiently, it's important for you to make sure that every one of these parts is in perfect condition and that every part works exactly as it was designed to work. Remember that if your unit doesn't work efficiently, neither will you. So in addition to cleaning and maintaining the Scott apparatus before and after you wear it, you must also test and inspect it regularly for signs of wear and damage.

Specifically, this means that the apparatus must be tested and inspected on a routine basis once every 30 days.

Reference: The reference for the 30-day testing is *30 CFR,* Section 49.6(b).

You should also test the apparatus after it's been transported from one place to another. A trip on a bumpy road could loosen couplings or otherwise cause the unit to malfunction.

Be sure to inspect the apparatus before every practice session. And never forget to test and inspect the unit before you wear it for actual rescue work. It may be an emergency and you may think you haven't got enough time to test it—but you've got to make the time. Once you're in the mine, your life depends on how well your apparatus functions.

Once you're experienced with the testing procedure, you should be able to run through it quickly and accurately.

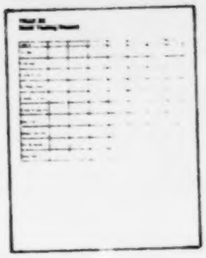
Recordkeeping

Keeping records of tests and repairs made on your apparatus is an important means of ensuring that your unit is always dependable. Accurate, well-kept records can tell you at a glance what condition your unit is in. When kept over long periods of time, records help to identify your unit's "weaknesses" and help you spot minor trouble areas that could turn into major malfunctions. Records also provide you with a basis for developing a replacement schedule for expendable parts.

Testing Records

Visual: Refer to "Visual 20" for a sample Testing Record.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Federal law requires that you keep an accurate record of each test and inspection performed on the apparatus. This record must be kept at the mine for a period of one year.

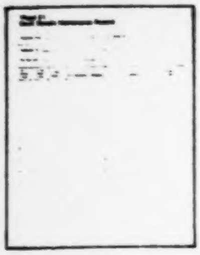
Reference: The reference for testing records is *30 CFR,* Section 49.6(b).

This record, which may be designed as a checklist, should include all inspections and tests performed on the apparatus. It should also include the date on which the unit was tested, the name of the person performing the tests, and the unit or serial number from the apparatus, the oxygen cylinder, and the manifold assembly. This record should also note what parts need to be replaced, if any are required.

Maintenance Records

Visual: Refer to "Visual 21" for a sample maintenance record.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



In addition to the test/inspection record required by Federal law, it is a good idea to keep a separate maintenance record for each apparatus.

A maintenance record should include:

1. **The total number of hours the apparatus has been used;**
2. **The installation date for any new part that has been put on the apparatus; and**
3. **The date on which the apparatus was first placed in service (if known).**

A record like this helps you establish a regular maintenance program for each apparatus.

Note: At this point, discuss your mine's schedule for and/or experience with replacing expendable parts such as hoses, breathing bags, washers, etc.

Tagging

Visual: Refer to "Visual 22" for a picture of sample tags.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

In addition to keeping testing and maintenance records, it's also a good idea to "tag" each apparatus so that key information can actually be affixed to the apparatus. This tag should be placed on the unit every time it is inspected, and it should include information such as:

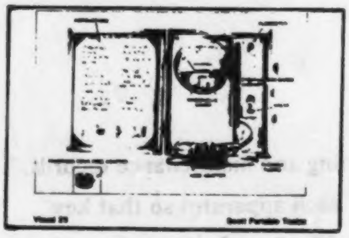
1. The apparatus number;
2. The most recent test date;
3. The name or initials of the person who tested the apparatus;
4. Any parts that have been removed for repairs; and
5. Whether or not the apparatus is ready for use.

It is suggested that a white tag be used if the apparatus has passed all inspection tests and is ready for use. If the unit is not functioning properly or has a part removed for repairs, a red tag should be used. Thus, you will know immediately by the color of the tag whether the apparatus can be used.

The Scott Portable Tester

Visual: Display a Scott Portable Tester so the team members can see it and/or refer to "Visual 23" for a picture of the tester. Point out the parts as you discuss them.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The Scott Portable Tester is used to test some of the Scott's functions to make sure the apparatus is operating properly. The Scott Tester, for instance, is used to measure the unit's "constant flow" (that is, the rate at which it delivers oxygen to the mixing chamber). You'll also need the tester to check the apparatus for leaks while it's under positive pressure, and to make sure the relief valve is operating properly.

The Scott Tester is a hinged black box with a carrying handle. When you're ready to use it, open the box and stand it upright. Inside the lid are instructions for using the tester. On the other side of the box are two instruments–a flow meter and a magnehelic gauge. Both instruments are graduated in order to measure air pressure in units known as "inches of water."

The rectangular instrument on the right is a flowmeter. It measures the rate of flow of oxygen flowing from the apparatus into the tester. The float inside the flowmeter rises and falls with the change in pressure. The green bands you see on the flowmeter clearly identify the points between which the float should stay if your apparatus is working properly.

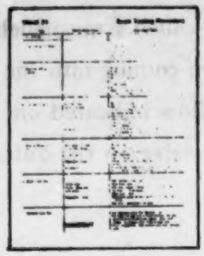
The round instrument on the left is called a magnehelic gauge. This gauge measures the pressure coming into the tester from the apparatus. Adjust the flow indicated on the magnehelic gauge by operating the valve on the bottom of the flowmeter.

The tester connects to the apparatus by means of the clear tubing that emerges from the tester below the flowmeter. At the opposite end of this tubing is a black rubber hose adaptor. The unit's breathing hoses fit into either end of this adaptor. When you check the unit's constant flow, you'll remove the hose adaptor from the tubing and connect the tubing directly to the unit's constant flow hose.

Note: If you use the Panorama Nova facepiece, it is necessary to use a special hose adaptor with the Scott Portable Tester. The adaptor is designed with a single fitting for the breathing hoses.

Visual: Refer to "Visual 24" for a chart showing the following test procedures. Point out each test on the chart as you discuss it here.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Testing Procedure

In this section, we'll prepare the Scott Rescue-Pak for use and test it to make sure it's operating properly. Remember to carry out these tests regularly, and always do them before the unit is worn—whether it's for practice or for actual rescue work.

Most of the procedures we'll cover here require the use of very little equipment other than an apparatus, it's face-piece and breathing hoses, the tester, and the accessories that come packed with the unit.

Note: Equipment needed for each particular test will be specified in the corresponding lecture section. In the first three steps, you'll simply check the unit and prepare it for use. You won't need the Scott tester until you get to Steps 4 through 6.

Step 1: Visual Inspection

The first step of the testing procedure is simply to look over the apparatus carefully for signs of wear or damage. This is known as "visual inspection."

Remove the unit, facepiece, and breathing hoses from the storage case and lay them out on a bench or table in front of you.

Note: Tell the team members to also remove the nut driver, anti-fog solution, and wiping tissue from the storage case so they'll have them for the tests to follow.

If you haven't already done so, disconnect the breathing hoses from the facepiece and from the apparatus. Carefully examine the hoses, facepiece, and harness web for signs of wear or damage. Stretch the hoses out so that you can inspect the folds of the corrugations. Examine all the rubber parts of the facepiece. Check the lens for scratches or cracks.

Step 2: Insert Oxygen Cylinder

If there's not a fully-charged oxygen cylinder in the apparatus, insert one in it now, using the nut driver provided with the unit.

Before you insert the cylinder, remember to inspect the two "O" rings on the valve assembly. Also make sure the metal washer is positioned around the opening for the attachment bolt. Once the cylinder is in the apparatus, secure it to the shell with the elastic straps.

Next, check the cylinder gauge to make sure you've got a full (1980 PSI) cylinder.

Step 3: Inserting the CO_2 Scrubbing Canister

Before you insert a canister, make sure you've got the right one for the type of work you'll be doing–white for training or silver for actual rescue work. If you're using a rescue canister, check the date stamped on it. It's suggested that you don't use a canister that's more than five years old.

Examine the canister carefully before you put it in the apparatus. Make sure it has no dents, bulges, or broken seams. It should also be free of rust. Make sure that the portal seals are in place and that they're not torn or damaged.

Now you're ready to insert the canister: First, remove the yellow dust covers that protect the end plenums. Then remove the adhesive seals from both portals on the canister. In the center of each canister portal is an attachment clip. Make sure that the clip is pushed to the center of the canister portal.

Visual: Point out the attachment clip on a canister and/or refer again to "Visual 8" for a picture of the clip.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Inspect the "O" ring type gasket inside each end plenum. Then place the canister in the apparatus, making sure that the arrows on the canister point in the same direction as the arrows on the end plenums–from left to right. Fit the end plenums over the canister portals and turn the clamp screw knobs clockwise until the end plenums fit snugly against the canister portals. Now secure the canister in the apparatus by fastening the clips on the elastic holding straps to the brackets in the shell. Once the canister is completely inside the apparatus, check again to make sure that the canister arrows point in the same direction as the arrows on the end plenums.

Note: You'll use the Scott Portable Tester for the next three tests. Perform these tests after you've prepared the apparatus for use as described in Tests 1-3. Make sure the unit is secure so it won't fall over.

Step 4: Constant Flow Rate Test

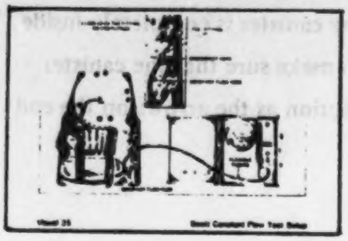
The first test you'll perform with the Scott Portable Tester is to check the unit's constant flow rate. This is an important test because if your constant flow rate is above or below what it should be, that means that your unit is delivering more or less oxygen than it should.

Note: Remember that the constant flow rate is about 1.5 liters per minute. On the flowmeter it's indicated by the area between the green bands.

In order to do this test, you'll need to connect the Scott Tester directly to the unit's constant flow hose. Here's how to set up the test:

Visual: Using the Scott Tester and an apparatus, set up the test so the team can see it and/or refer to "Visual 25" for a picture of the setup.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



1. **Disconnect the black rubber hose adaptor from the end of the flexible tubing leading from the tester.**

2. **Remove the back cover of the apparatus. Using a wrench, disconnect the constant flow hose from the lower end of the "tee" fitting on the mixing chamber. Then connect the constant flow hose to the tester's flexible tubing.**

Visual: Point out the lower part of the "tee" fitting and the constant flow hose on an apparatus and/or refer again to "Visual 25" for a picture of the parts.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

3. **Now open the valve on the Tester's flowmeter one turn counterclockwise. (This will allow air to flow into the tester from the unit once the unit is turned on.)**

4. **Open the cylinder valve and listen for the "click" that indicates the alarm is setting itself. If you don't hear the click, chances are that the alarm isn't working properly, so don't use the unit. See that it's repaired.**

5. **Open the cylinder valve and the mainline valve on the apparatus to get oxygen flowing through the circuit.**

6. **Now, watch the position of the float on the flowmeter. It should rise to the area between the green bands and stay there.**

Warning: If the float does not rise, do not push the bypass valve. Check to make sure the proper hose is connected to the flow meter.

7. **Close the mainline valve and the valve on the flowmeter. Disconnect the tester's tubing from the constant flow hose and reconnect the constant flow hose to the mixing chamber in the apparatus. Then put the rubber hose adaptor back on the end of the flexible tubing. Replace the back cover on the unit to get it ready for the next test.**

Note: If you perform the constant flow test exactly as it's described here, and the float on the flowmeter doesn't remain steady between the green bands–don't use the apparatus. Withdraw it from service and send it back to the manufacturer for repair.

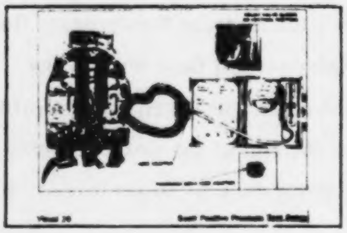
Step 5: Positive Pressure Leak Test

This test checks to make sure that no air leaks out of the unit while it's under positive pressure. Remember that normally air can escape from the unit through the pressure relief valve. The air that escapes in this manner isn't really a "leak," but it will show up as a leak when you do the test unless you close the pressure relief shutoff switch first.

Here's the complete test procedure:

Visual: Show the team how to do the test setup with the apparatus and tester and/or refer again to "Visual 26" for a picture of the setup.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



1. **If you haven't already done so, disconnect the hoses from the facepiece. Then connect the breathing hoses to the fittings on the apparatus.**
2. **Connect the opposite ends of the breathing hoses to the black hose adaptor on the tester.**

3. **Open the mainline valve on the unit and close the relief valve by flipping the relief valve shutoff lever on the back of the unit up (to the vertical position).**

4. **Now, regulate the flow of air in the system by adjusting the valve below the flowmeter until the magnahelic gauge reads two inches of water. Be sure to allow enough time for the pressure to increase.**

5. **As you did in the last test, watch the position of the float in the flowmeter. It should remain steady between the green bonds.**

6. **If the float in the flowmeter is below the green bands, that indicates there's a leak somewhere. This could be something simple like a loose connection, or it could be something a little more complicated--like a damaged hose, a misaligned diaphragm, or a gasket that needs to be replaced.**

   So check all the fittings for leaks with soapy water or another leak detection solution that's safe to use around oxygen. Do this leak check with the system pressurized to 2 inches of water, as indicated on the magnehelic gauge.

   Once you've located the leak, tighten, replace, or repair the part, and then retest the unit.

7. **If you do the positive pressure leak test as it is described here and the float in the flowmeter goes above the green bands, don't use the unit. Have it repaired.**

Step 6: Relief Valve Test

This test checks the relief valve to make sure it's venting excess pressure as it should. The test setup for this one is basically the same as the last, with one important exception: The relief valve shutoff switch must be opened so that the relief valve can operate.

Here's how to do the relief valve test:

Visual: Show the team members this test setup with the tester and apparatus and/or refer to "Visual 27" for a picture of the setup.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Visual 27 Scott Pressure Relief Valve Test Setup

1. With everything set up as it was in the last test, open the pressure relief valve by flipping the shut-off lever on the back of the apparatus down (to the horizontal position).

2. Turn the valve on the portable tester to the "off" position.

3. **Disconnect the plastic tubing from the hose adaptor to relieve some of the excess pressure that built up in the system during the positive pressure leak test.**

4. **Reconnect the plastic tubing to the hose adaptor and open the tester valve.**

5. **Now, watch the needle on the magnehelic gauge. It should rise to about one inch and hold steady. (A reading between 1 inch and 2 inches is also acceptable.)**

6. **You won't need the Scott Tester for the next test, so disconnect it from the hose adaptor and turn the tester valve off.**

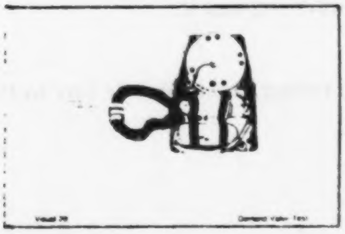
Step 7: Demand Valve Test

Remember that when you need more oxygen than the 1.5 liters per minute your unit normally provides, the demand valve responds by letting more oxygen into the system. This test checks the demand valve to make sure it's operating. To do this, you'll mimic what happens when you breathe down the bag by pressing the diaphragm down by hand, and then waiting for the demand valve to kick in.

Here's how you do the test:

Visual: Show the team members this test setup with the hose adaptor and apparatus and/or refer to "Visual 28" for a picture of the setup.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



1. **If you haven't already done so, disconnect the hose adaptor from the tester, but leave the adaptor connected to the hoses. Place the apparatus flat on a table or bench and remove the cover.**

Note: If the breathing hoses are not closed off by the adaptor, and the unit is placed flat, the weight of the diaphragm will carry it down onto the demand valve and turn it full on. Without restriction of the breathing hoses, the free flow will continue out through the fittings.

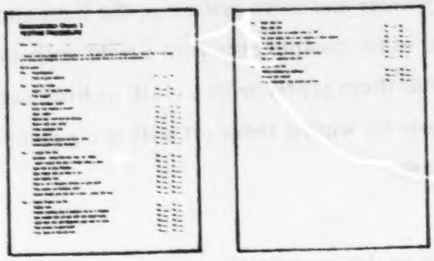
2. **Put your finger through one of the holes on the breathing bag cover and press down on the diaphragm until the metal disc in the center of it makes contact with the plunger that operates the demand valve.**

3. **You should feel the plunger move down and hear a rush of air indicating that the demand valve is working to let more oxygen into the system. You'll also feel the breathing bag begin to inflate as air enters it.**

4. **If the demand valve doesn't operate when you perform this test, disassemble the breathing bag. Then clean the demand valve, and try moistening it with a little water to keep it from sticking. If you do all of this and the valve still doesn't work, replace it.**

This is the end of the testing procedure. Be sure to turn off the mainline valve.

Demonstration check: Have each team member perform the complete testing procedure on an apparatus. Use copies of *Demonstration Check 3–Testing Procedure* provided at the back of this module to check each team member's performance.



Note: If you're not planning to use the apparatus immediately, turn the cylinder valve off at this point, replace the cover, and prepare it for storage. If you're going to store the unit, remove the scrubbing canister and discard it.

PERIODIC MAINTENANCE

Besides the testing and maintenance procedures we've talked about so far, there are some other things you should do regularly to keep your apparatus running smoothly and efficiently.

For example, remember to send the oxygen cylinder for hydrostatic testing every five years.

You should also open the breathing bag and inspect it periodically. It's suggested you do this after every twelve wearings, or every six months.

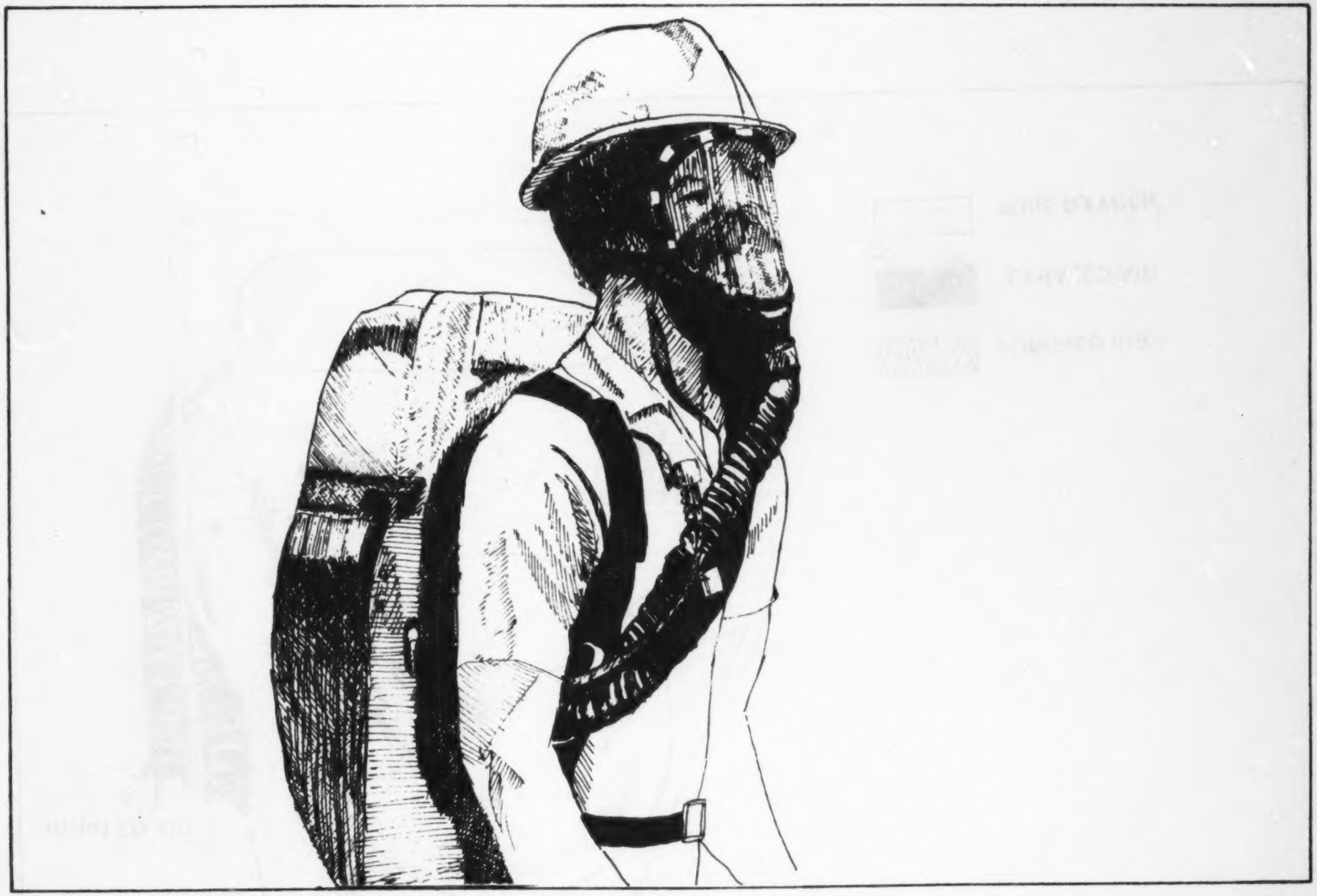
To inspect the bag, remove the top cover and lift the diaphragm out. Examine the diaphragm for holes, rips, cracks, or other signs of deterioration. Replace the diaphragm if necessary.

Wash the inside of the breathing bag, the diaphragm, the outside of the cylinder and valve assembly, the inlet and outlet hoses, and other components with a mild soap and warm water. Scrub them gently with a cloth or brush and then rinse the parts by wiping them off with a rag dampened in clean warm water.

Allow the parts to dry completely, and then reassemble the breathing bag.

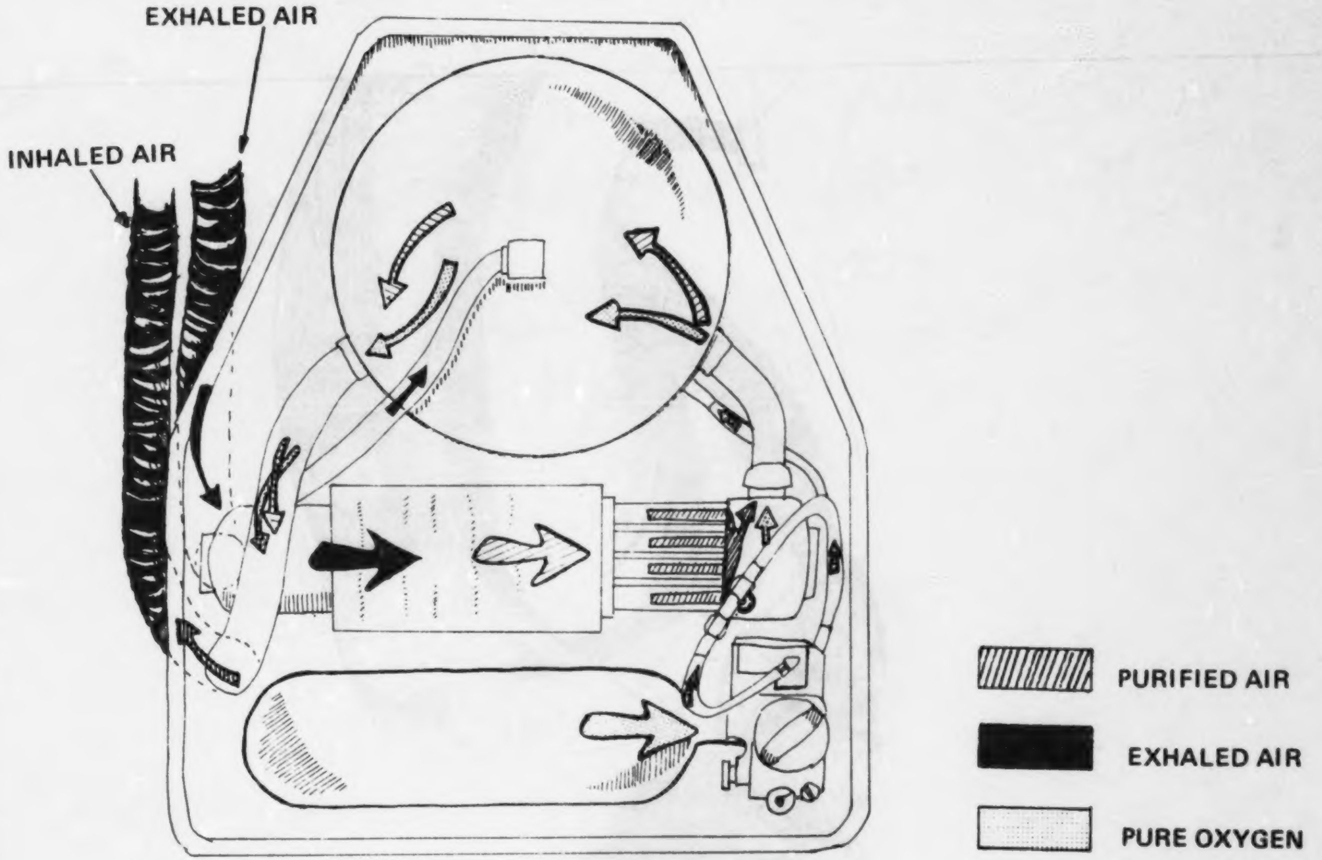
Regularly inspect the rubber parts of the apparatus, such as hoses, gaskets, and seals on end plenums. If they're damaged, replace them.

Note: In the case of self-sealing edges on hoses, you'll just need to cut off the worn sealing edge and move the corrugated part up one notch to make a new sealing edge.



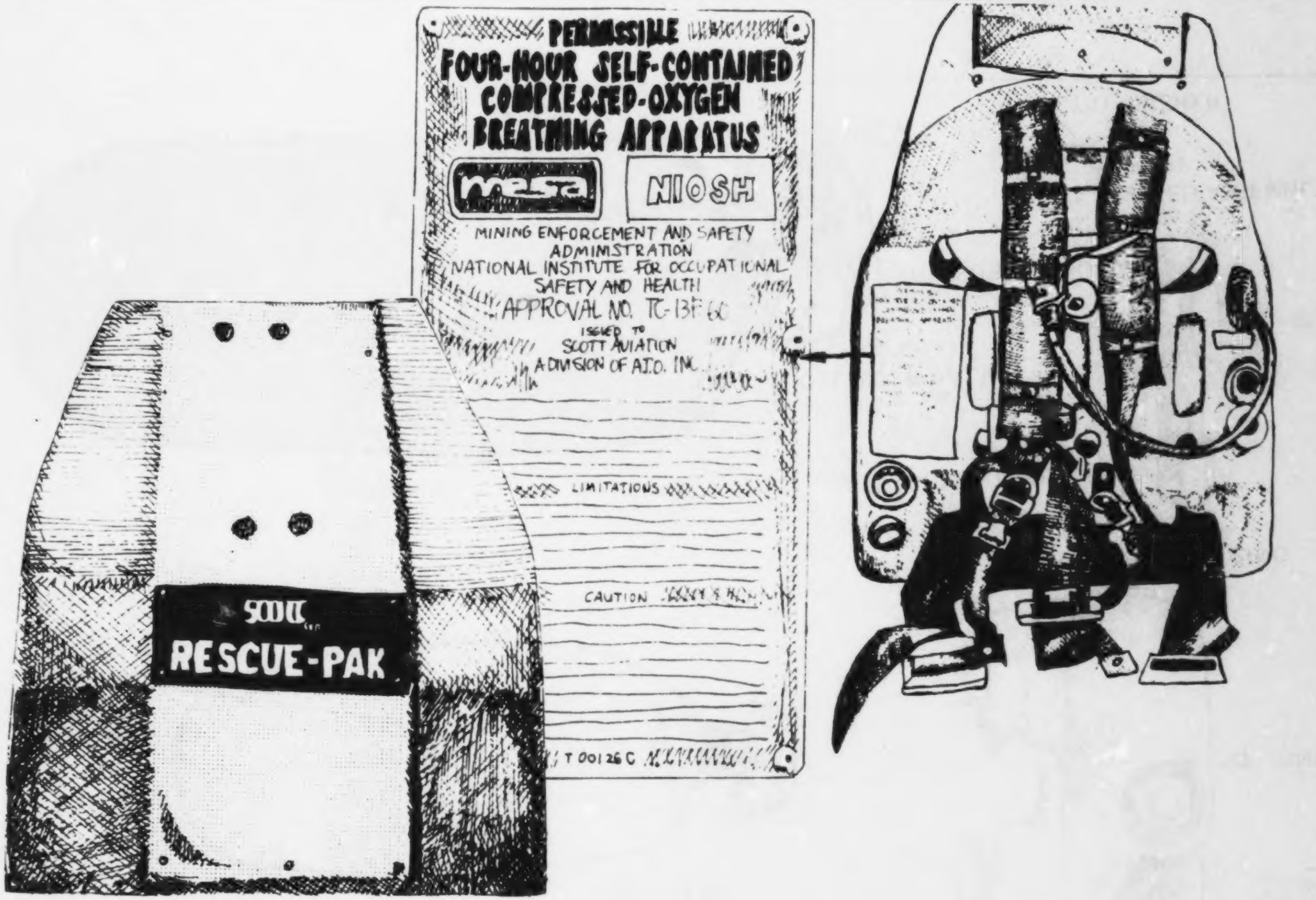
Visual 1

Scott Rescue–Pak


EXHALED AIR
INHALED AIR
PURIFIED AIR
EXHALED AIR
PURE OXYGEN

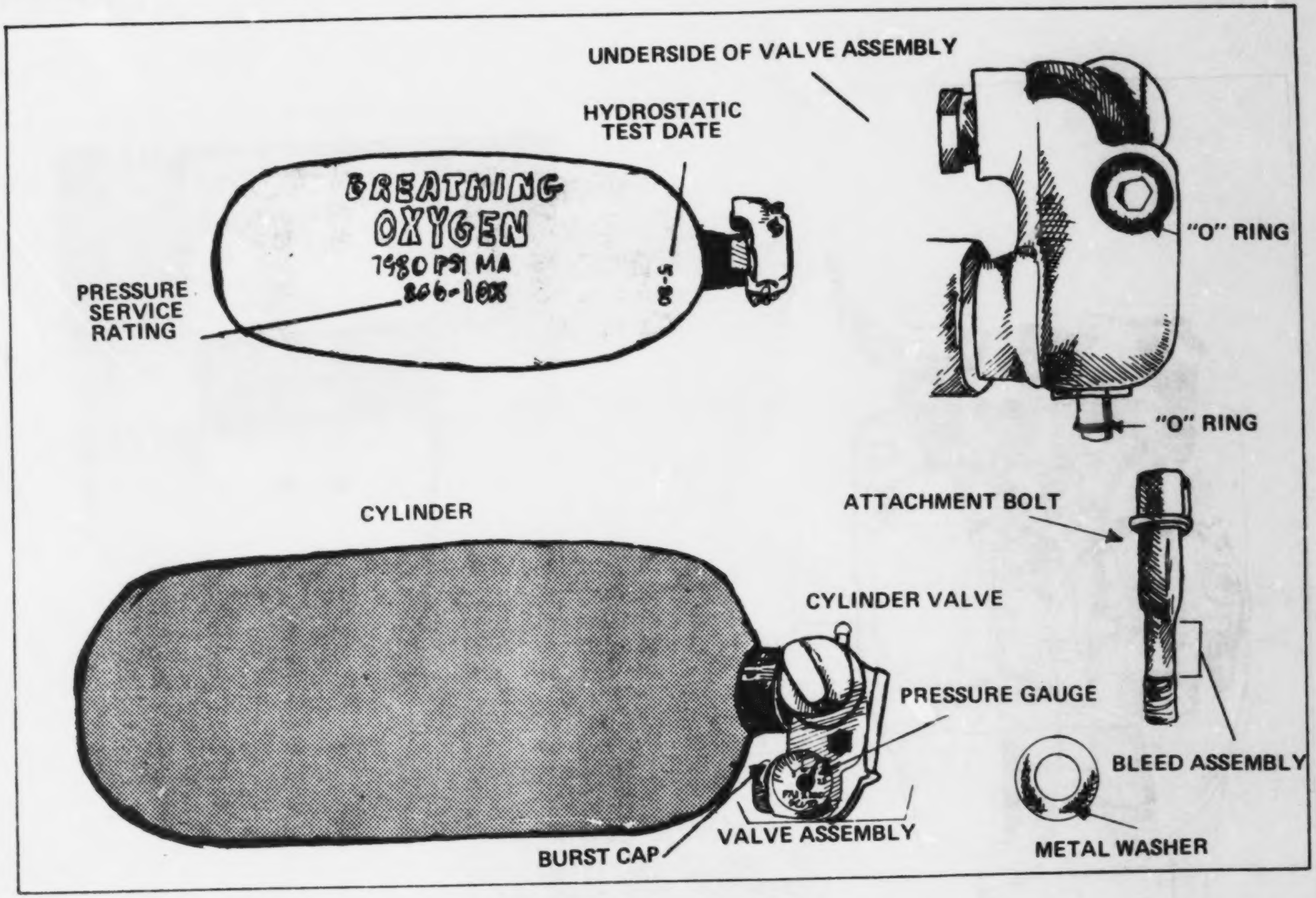
Visual 2

Scott Breathing Circuit


PERMISSIBLE
FOUR-HOUR SELF-CONTAINED
COMPRESSED-OXYGEN
BREATHING APPARATUS
mesa
NIOSH
MINING ENFORCEMENT AND SAFETY
ADMINISTRATION
NATIONAL INSTITUTE FOR OCCUPATIONAL
SAFETY AND HEALTH
APPROVAL NO. TC-13F-60
ISSUED TO
SCOTT AVIATION
A DIVISION OF A.T.O. INC.
LIMITATIONS
CAUTION
T 00126 C
SCOTT
RESCUE-PAK

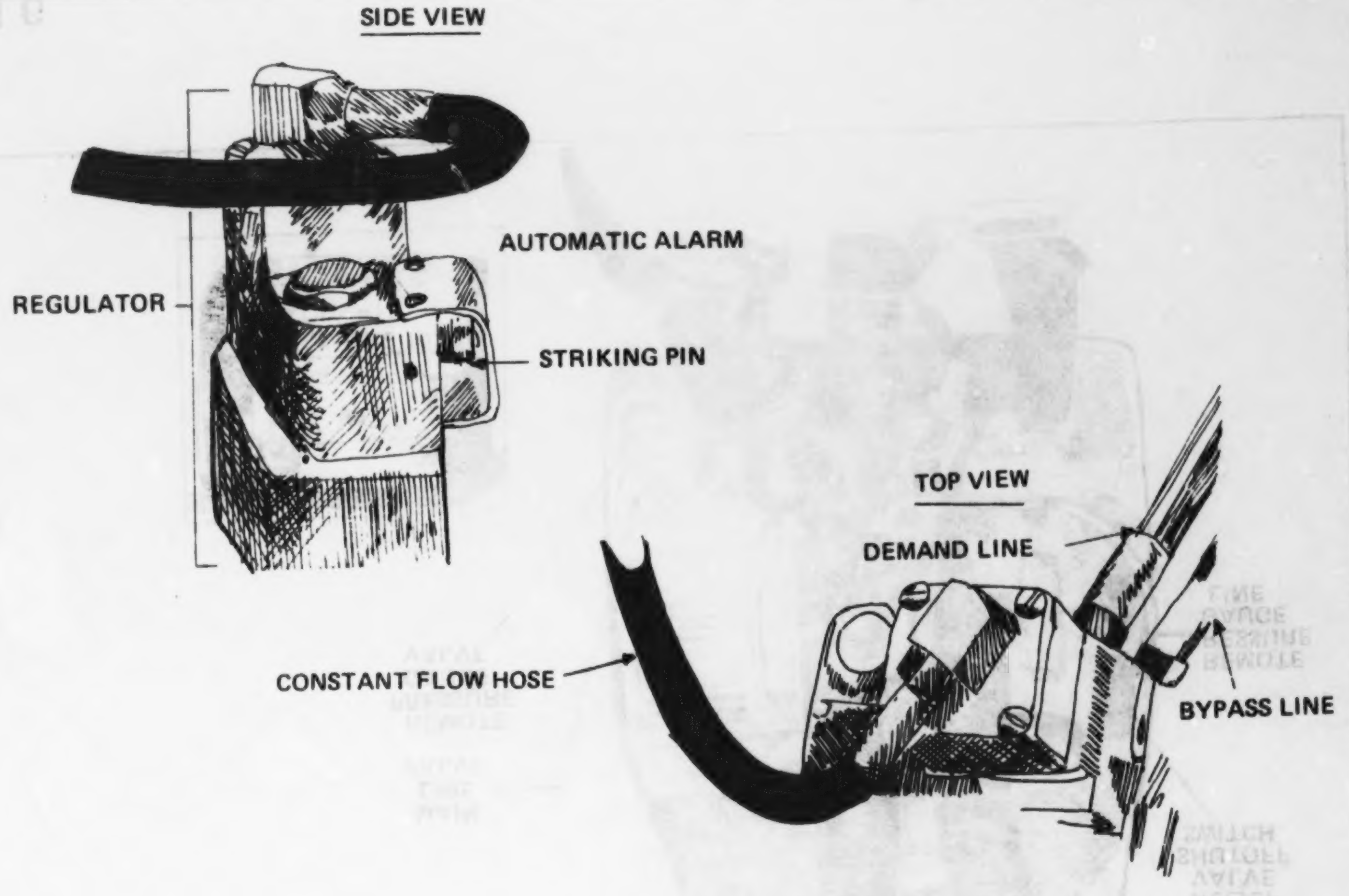
Visual 3

Scott Cover and Wearing Harness

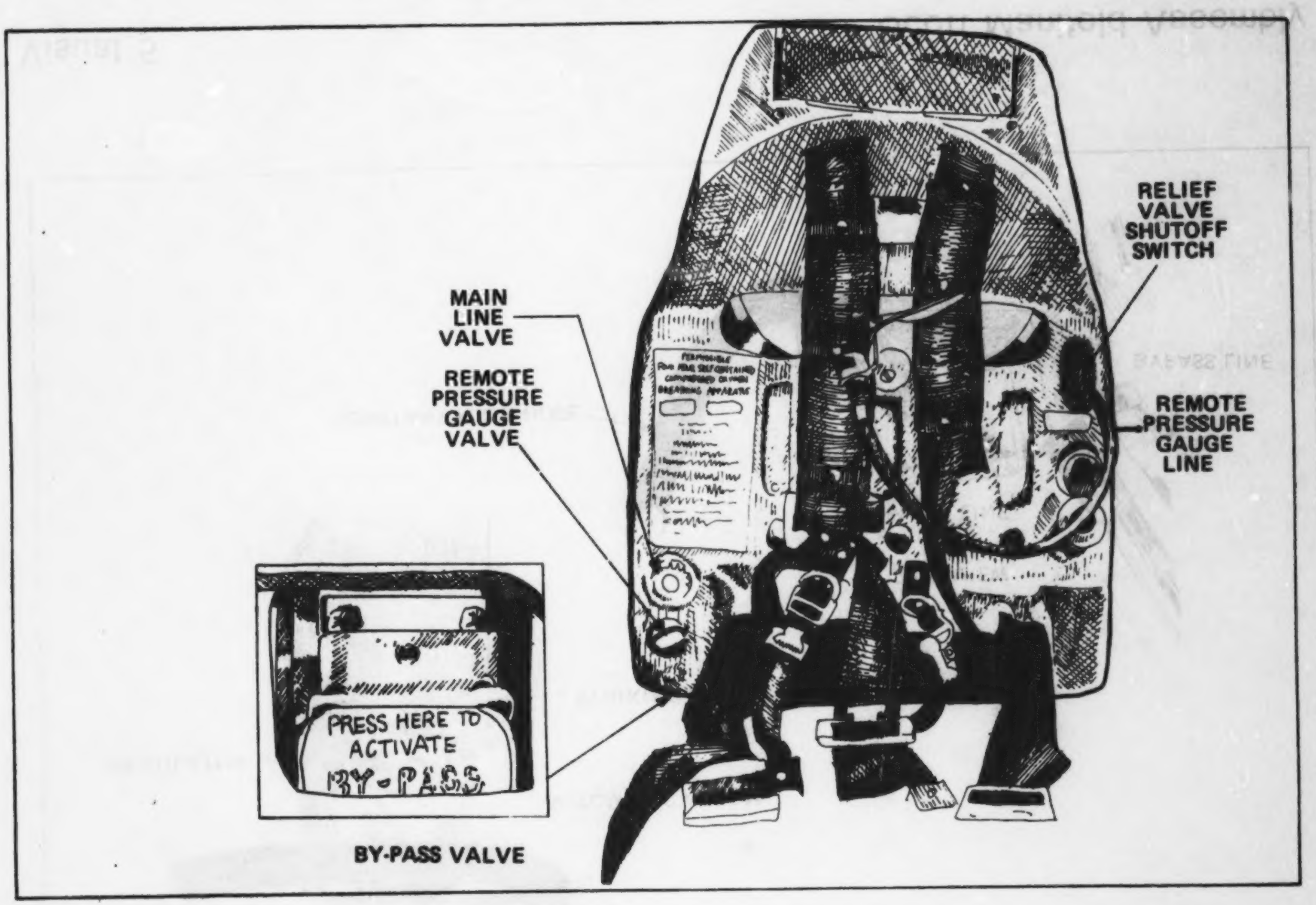

UNDERSIDE OF VALVE ASSEMBLY
HYDROSTATIC TEST DATE
BREATHING
OXYGEN
1980 PSI MA
806-10X
5-80
PRESSURE SERVICE RATING
"O" RING
"O" RING
ATTACHMENT BOLT
CYLINDER
CYLINDER VALVE
PRESSURE GAUGE
BLEED ASSEMBLY
METAL WASHER
VALVE ASSEMBLY
BURST CAP

Visual 4

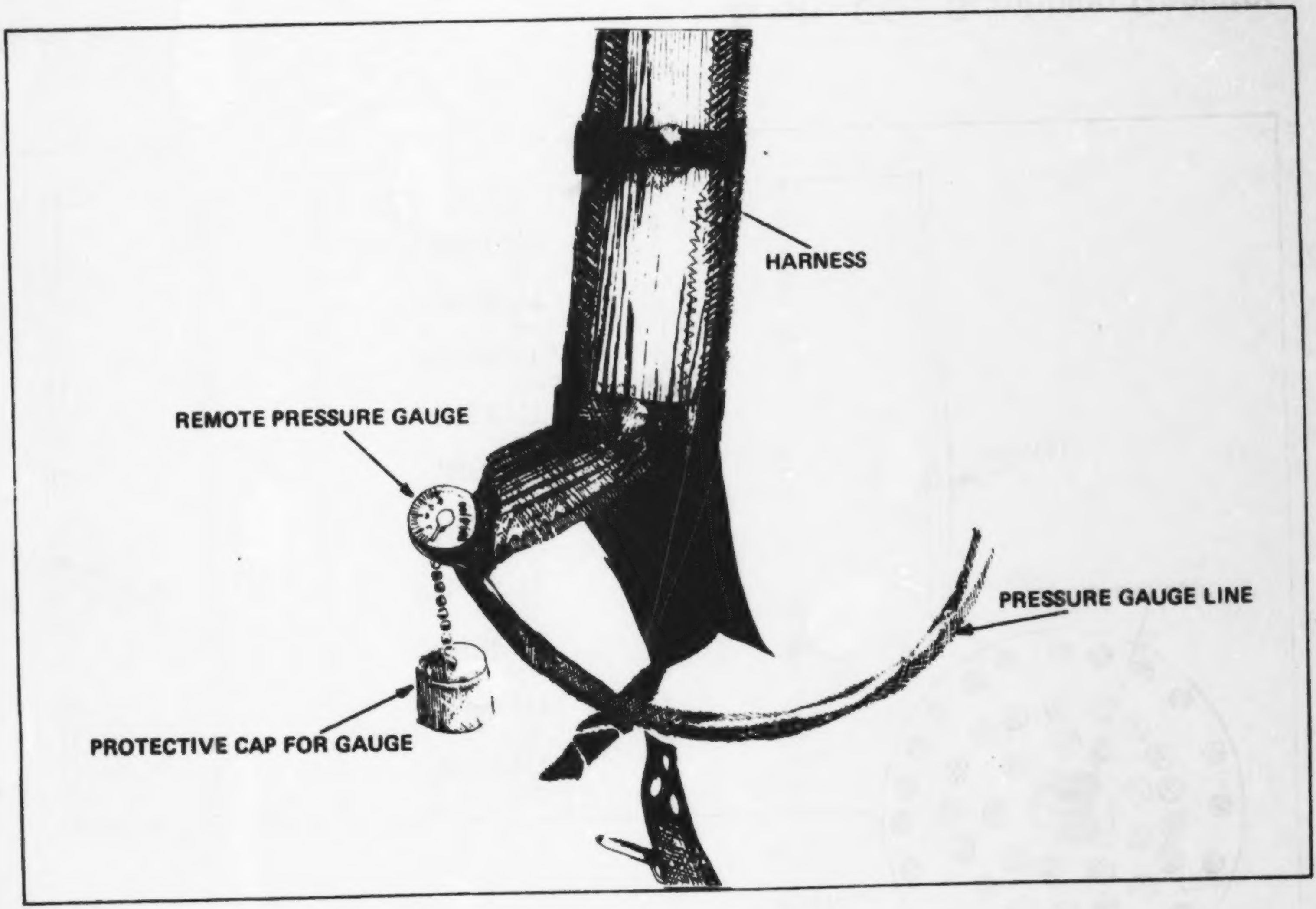
Scott Cylinder Valve Assembly


SIDE VIEW
REGULATOR
AUTOMATIC ALARM
STRIKING PIN
TOP VIEW
DEMAND LINE
CONSTANT FLOW HOSE
BYPASS LINE

Visual 5 Scott Manifold Assembly

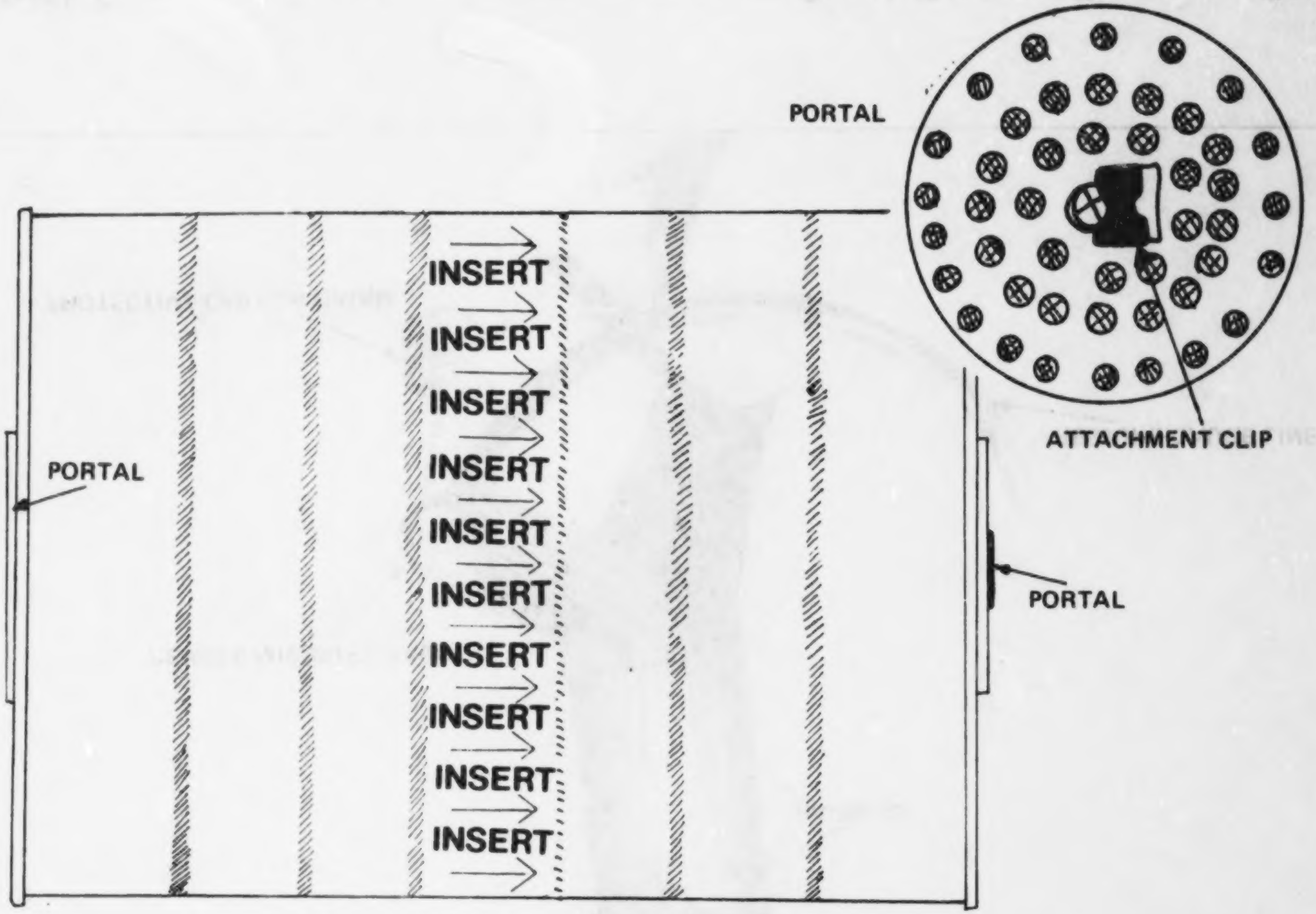

MAIN LINE VALVE
REMOTE PRESSURE GAUGE VALVE
RELIEF VALVE SHUTOFF SWITCH
REMOTE PRESSURE GAUGE LINE
PRESS HERE TO ACTIVATE BY-PASS
BY-PASS VALVE

Visual 6 Scott Manual Controls

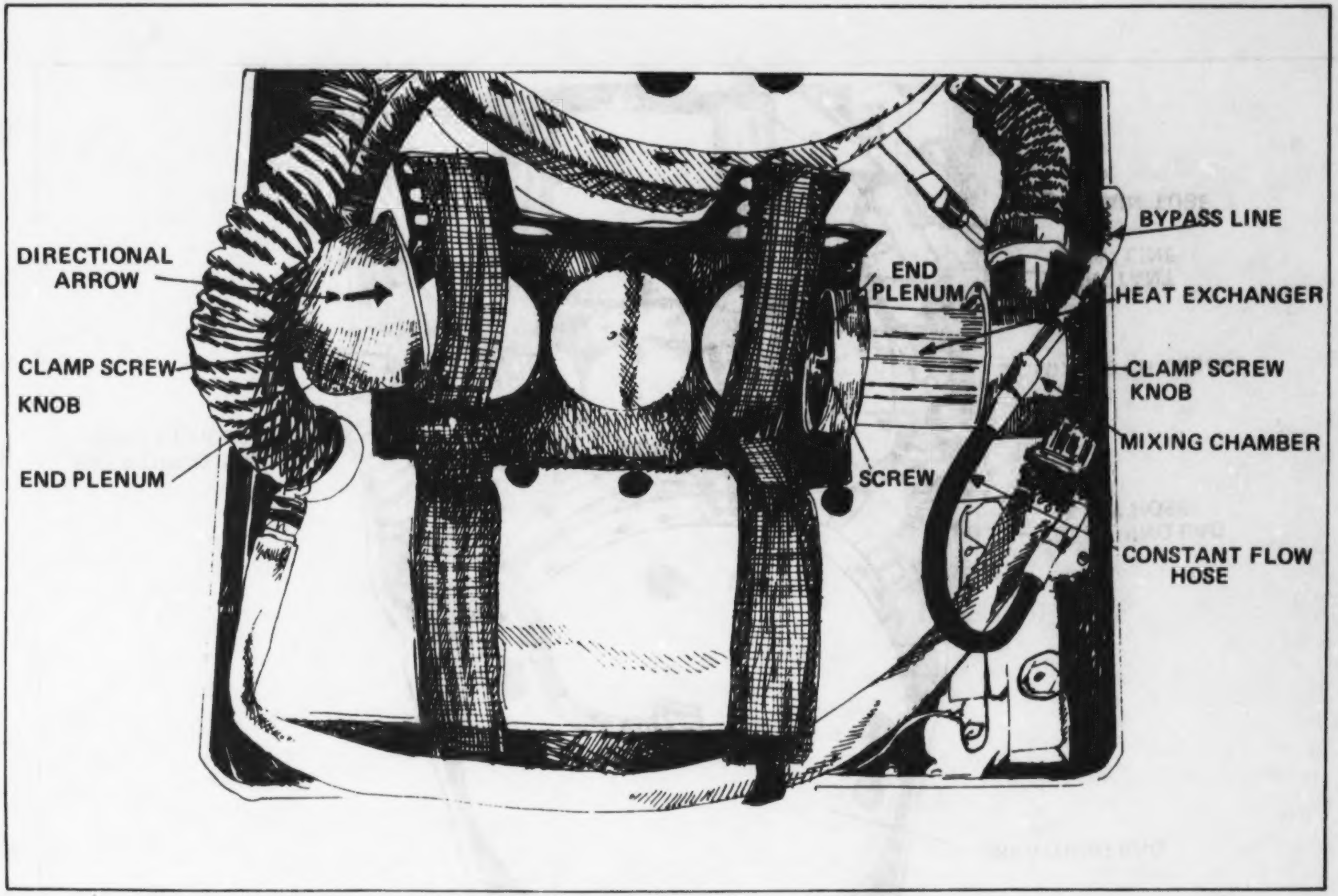

HARNESS
REMOTE PRESSURE GAUGE
PRESSURE GAUGE LINE
PROTECTIVE CAP FOR GAUGE

Visual 7

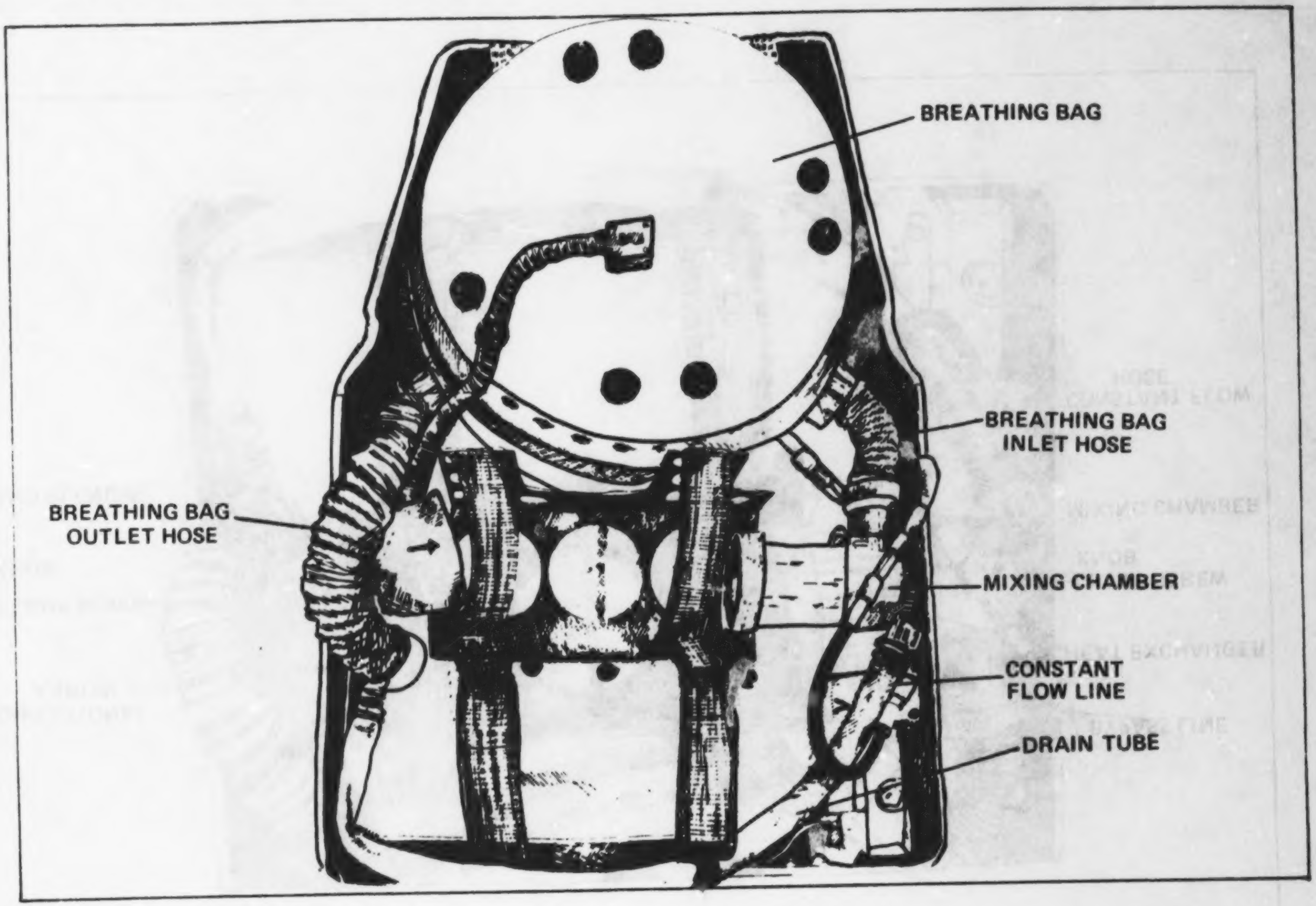
Scott Remote Pressure Gauge


PORTAL
PORTAL
INSERT
INSERT
INSERT
INSERT
INSERT
INSERT
INSERT
INSERT
INSERT
INSERT
ATTACHMENT CLIP
PORTAL

Visual 8 Scott CO_2 Scrubbing Canister

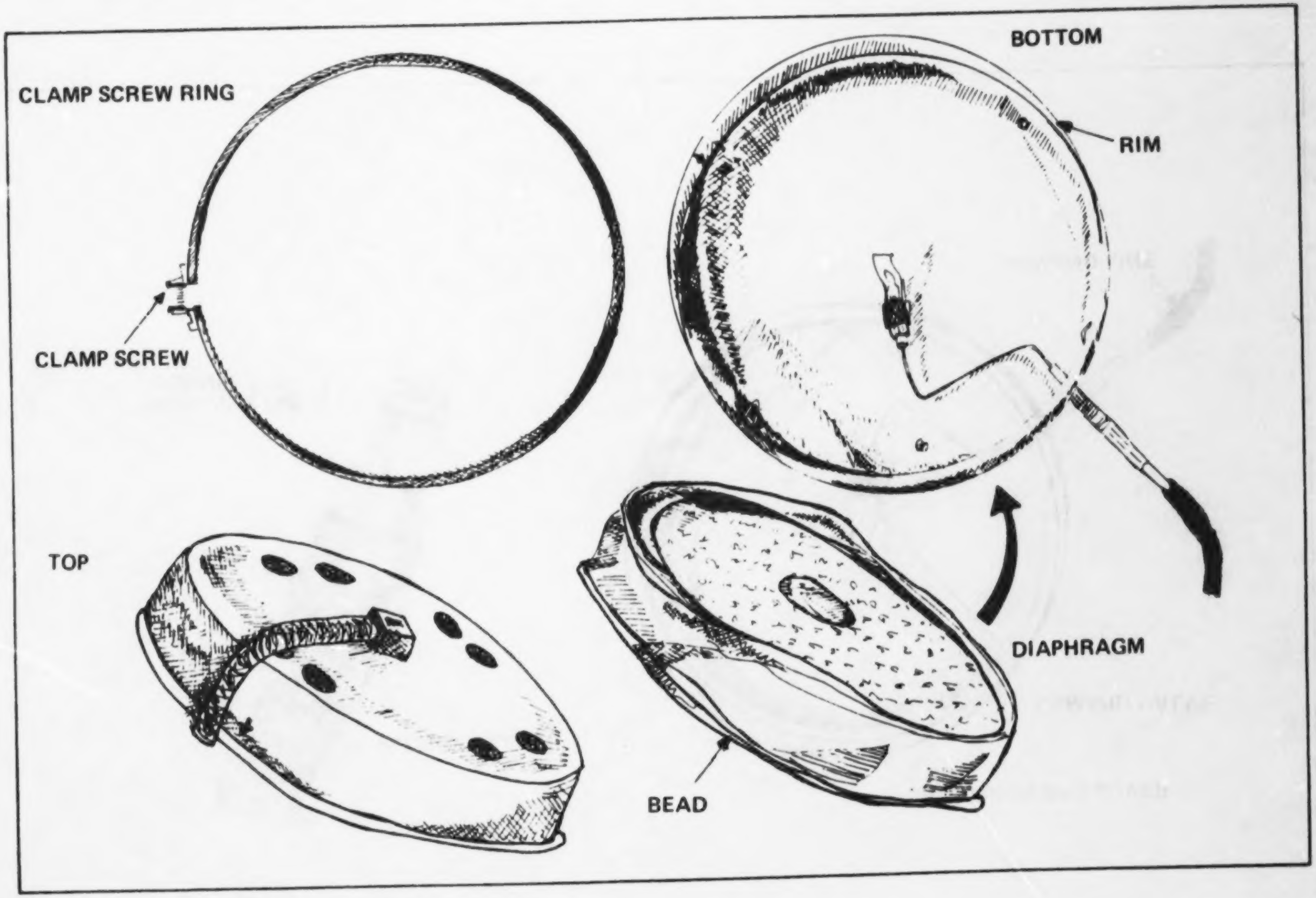

DIRECTIONAL ARROW
CLAMP SCREW KNOB
END PLENUM
END PLENUM
SCREW
BYPASS LINE
HEAT EXCHANGER
CLAMP SCREW KNOB
MIXING CHAMBER
CONSTANT FLOW HOSE

Visual 9 Scott Rebreather Section Parts


BREATHING BAG
BREATHING BAG INLET HOSE
BREATHING BAG OUTLET HOSE
MIXING CHAMBER
CONSTANT FLOW LINE
DRAIN TUBE

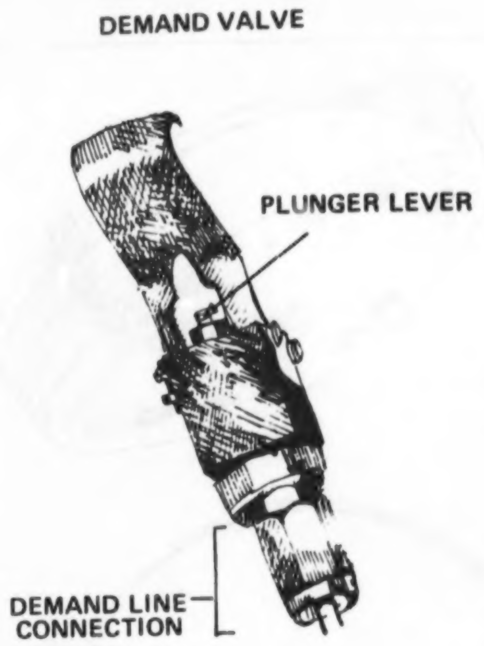
Visual 10

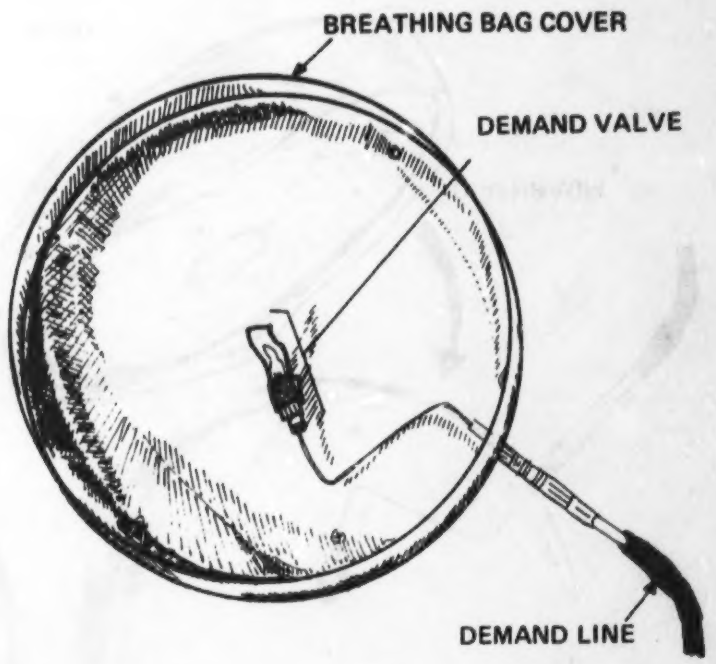
Scott Breathing Bag


CLAMP SCREW RING
CLAMP SCREW
BOTTOM
RIM
TOP
DIAPHRAGM
BEAD

Visual 11

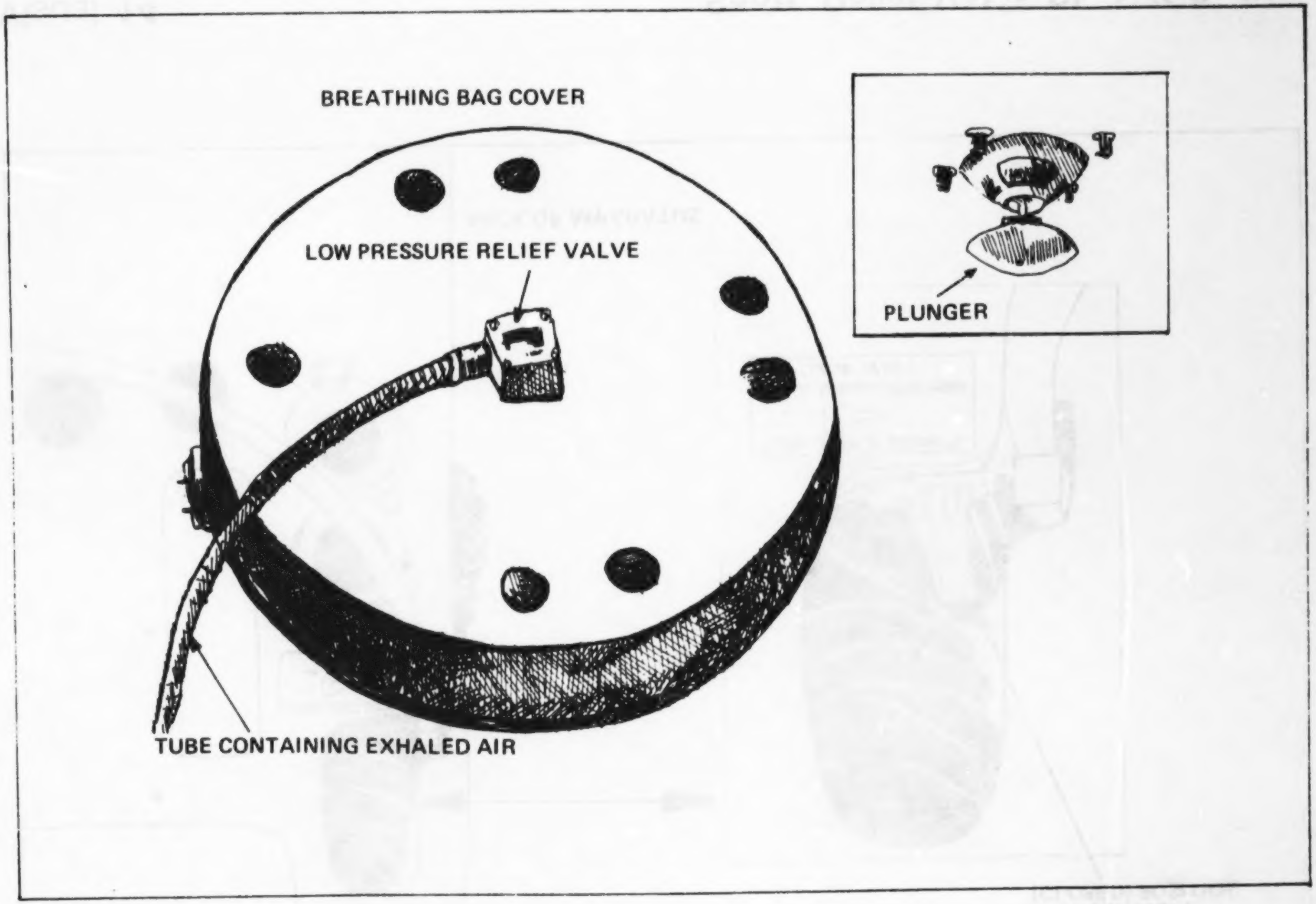
Scott Breathing Bag Parts


DEMAND VALVE
PLUNGER LEVER
DEMAND LINE CONNECTION

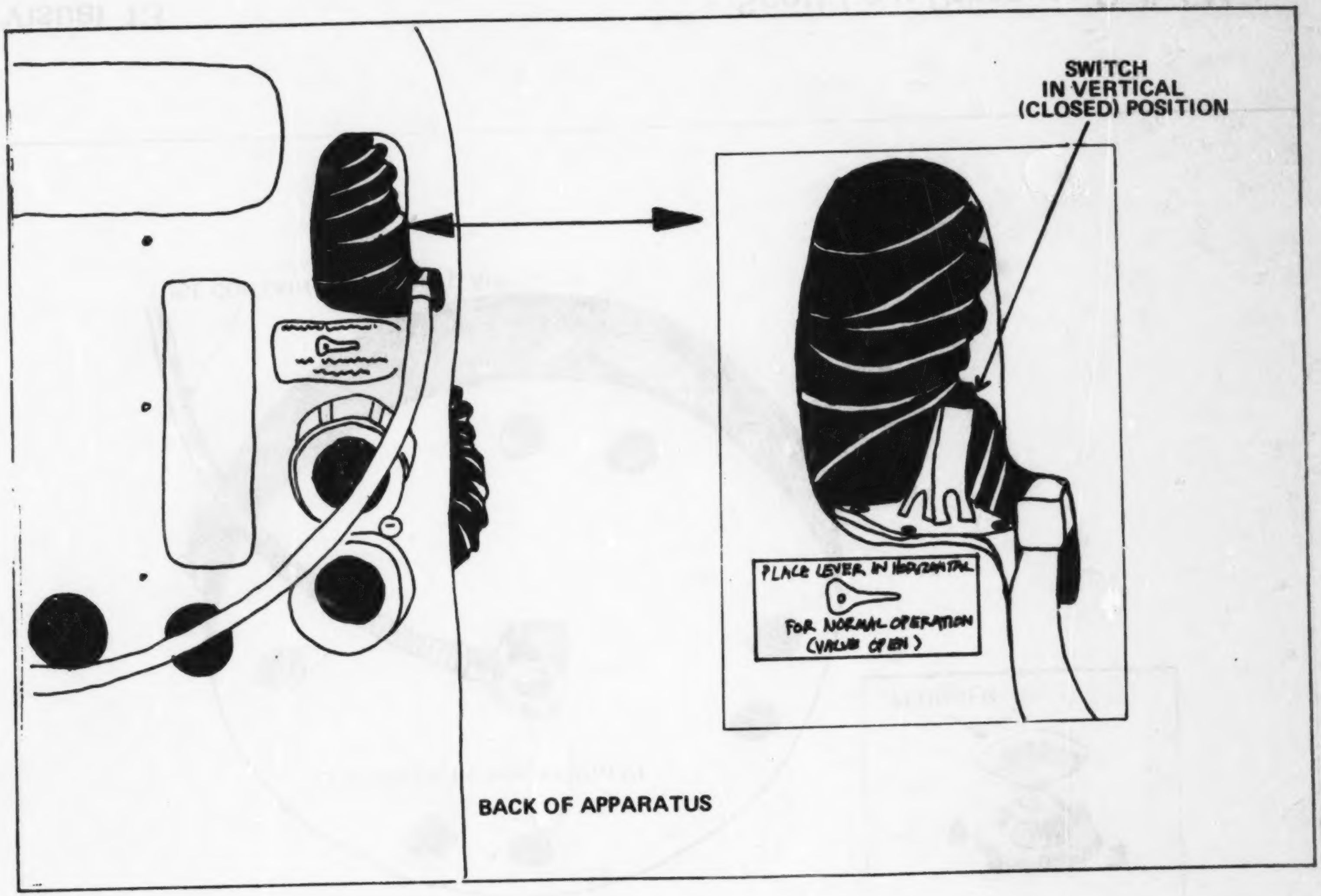

BREATHING BAG COVER
DEMAND VALVE
DEMAND LINE

Visual 12

Scott Demand V lve

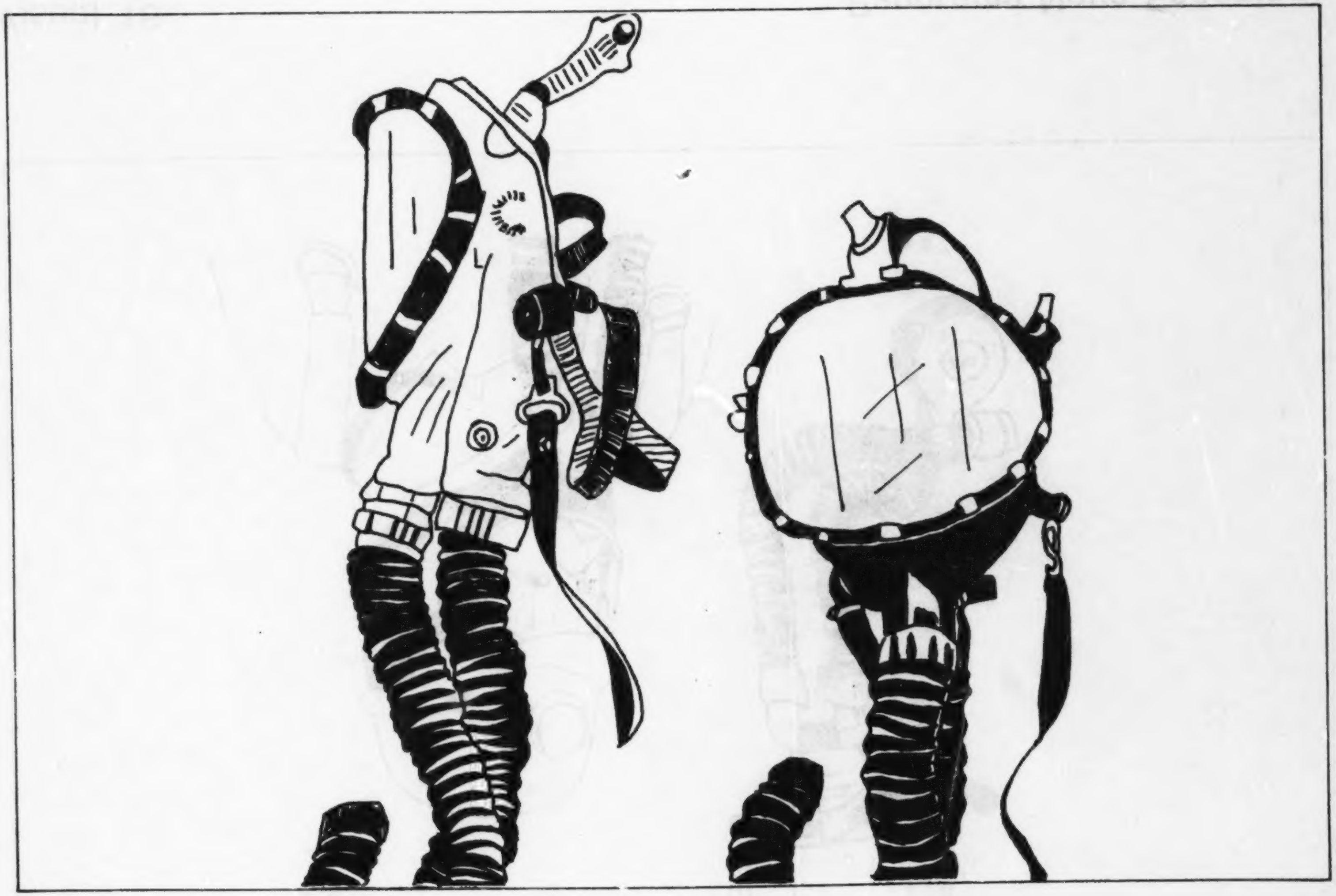

BREATHING BAG COVER
LOW PRESSURE RELIEF VALVE
TUBE CONTAINING EXHALED AIR
PLUNGER

Visual 13 Scott Low Pressure Relief Valve

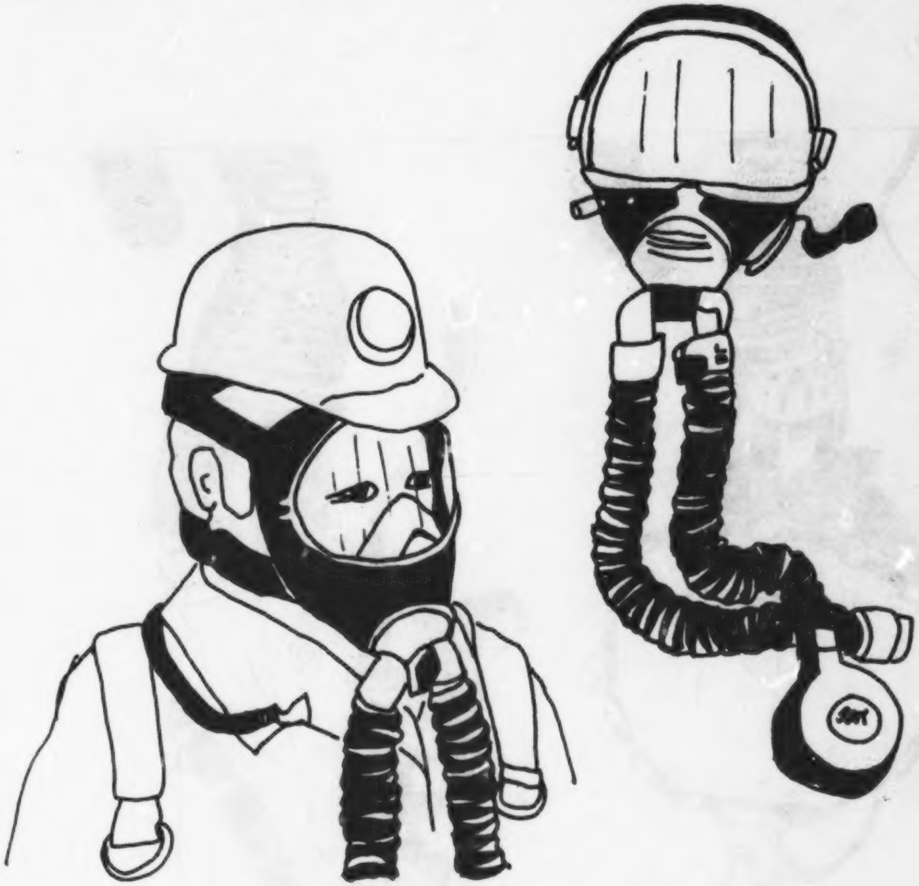

SWITCH
IN VERTICAL
(CLOSED) POSITION
PLACE LEVER IN HORIZONTAL
FOR NORMAL OPERATION
(VALVE OPEN)
BACK OF APPARATUS

Visual 14

Scott Relief Valve Shutoff Switch



Visual 15 Scottoramic Facepiece



Visual 16

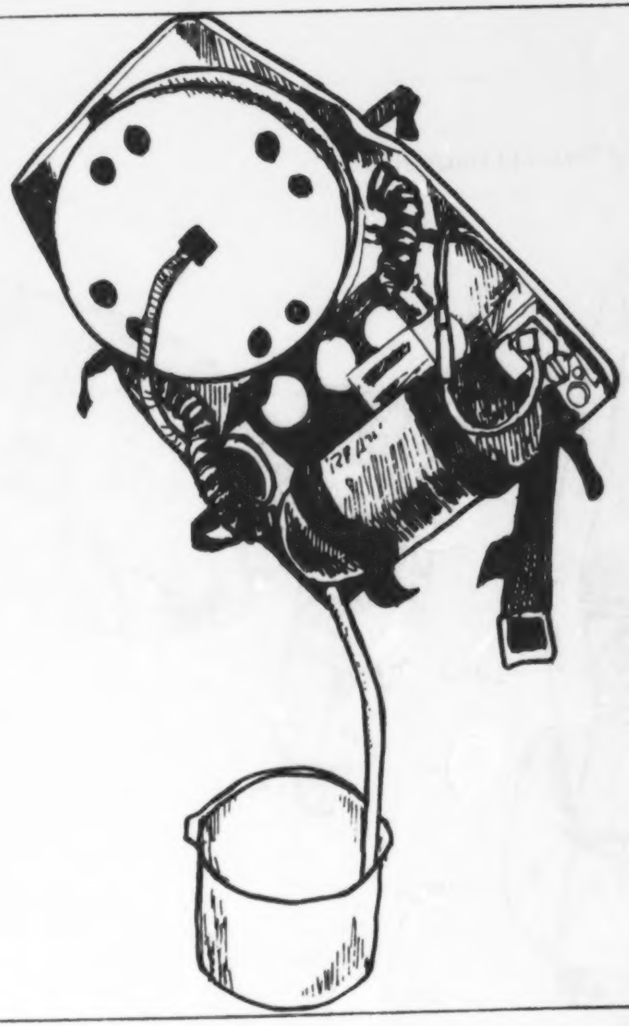
Panorama Nova Facepiece

Visual 17

Scott Emergency Backup Procedures

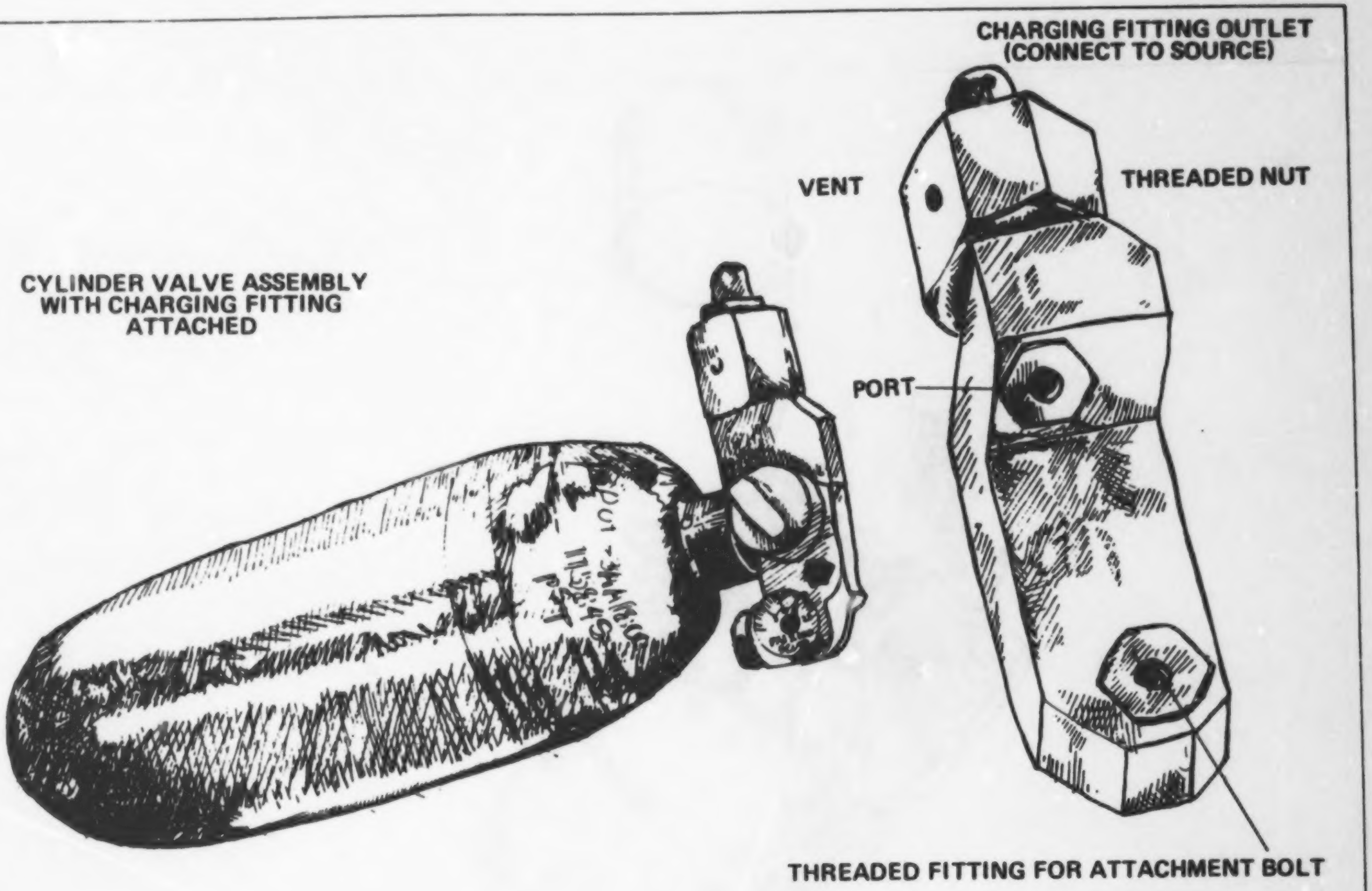
Problem	Solution
1. Regulator fails or demand valve malfunctions so that you don't get enough oxygen.	1. Depress bypass valve momentarily. Then release. Press again as you need more oxygen.
2. Regulator dumps oxygen, or demand valve sticks open. This causes waste of oxygen, pressure in facepiece.	2. Close mainline valve. Depress bypass to get oxygen. Breathe down bag. Repeat.
3. Both mainline valve and bypass valve stick in the open position. Wastes oxygen.	3. Lift cover and close cylinder valve. Use cylinder valve as you would bypass, opening momentarily to get oxygen, then closing. Open as needed.
4. Alarm sounds and continues to sound for one minute or more. Indicates only about 15 minute's worth of oxygen remaining. Can waste oxygen.	4. To conserve oxygen: Lift cover and close cylinder valve. Use cylinder valve as you would use bypass, opening momentarily to get oxygen, then closing. Open as needed.
5. Relief valve sticks open and continuously vents air to outside. Wastes air.	5. Close relief valve shutoff switch by flipping it up (to vertical position).
6. Remote pressure gauge line rips, ruptures, or is otherwise damaged and begins to leak. Wastes oxygen.	6. Close remote pressure gauge valve (green knob on back of unit). To keep track of how much oxygen you have, open cover and read cylinder gauge.
7. You are trapped in the mine and need to slow down the rate at which you consume oxygen.	7. Remain quiet. Turn off mainline valve and flip pressure relief valve up into vertical (or closed) position. Breathe down bag. Use bypass to get more oxygen. Repeat as needed.

HANDOUT



Visual 18

Draining the Scott Unit


CYLINDER VALVE ASSEMBLY WITH CHARGING FITTING ATTACHED
CHARGING FITTING OUTLET (CONNECT TO SOURCE)
VENT
THREADED NUT
PORT
THREADED FITTING FOR ATTACHMENT BOLT

Visual 19

Scott Charging Fitting

Visual 20
Scott Testing Record

UNIT #							
Test Date							
Visual Inspection							
Cylinder Pressure							
Scrubbing Canister							
Constant Flow Test							
Positive Pressure Test							
Relief Valve Test							
Demand Valve Test							
Test OK (Initials)							
Replacement Parts							

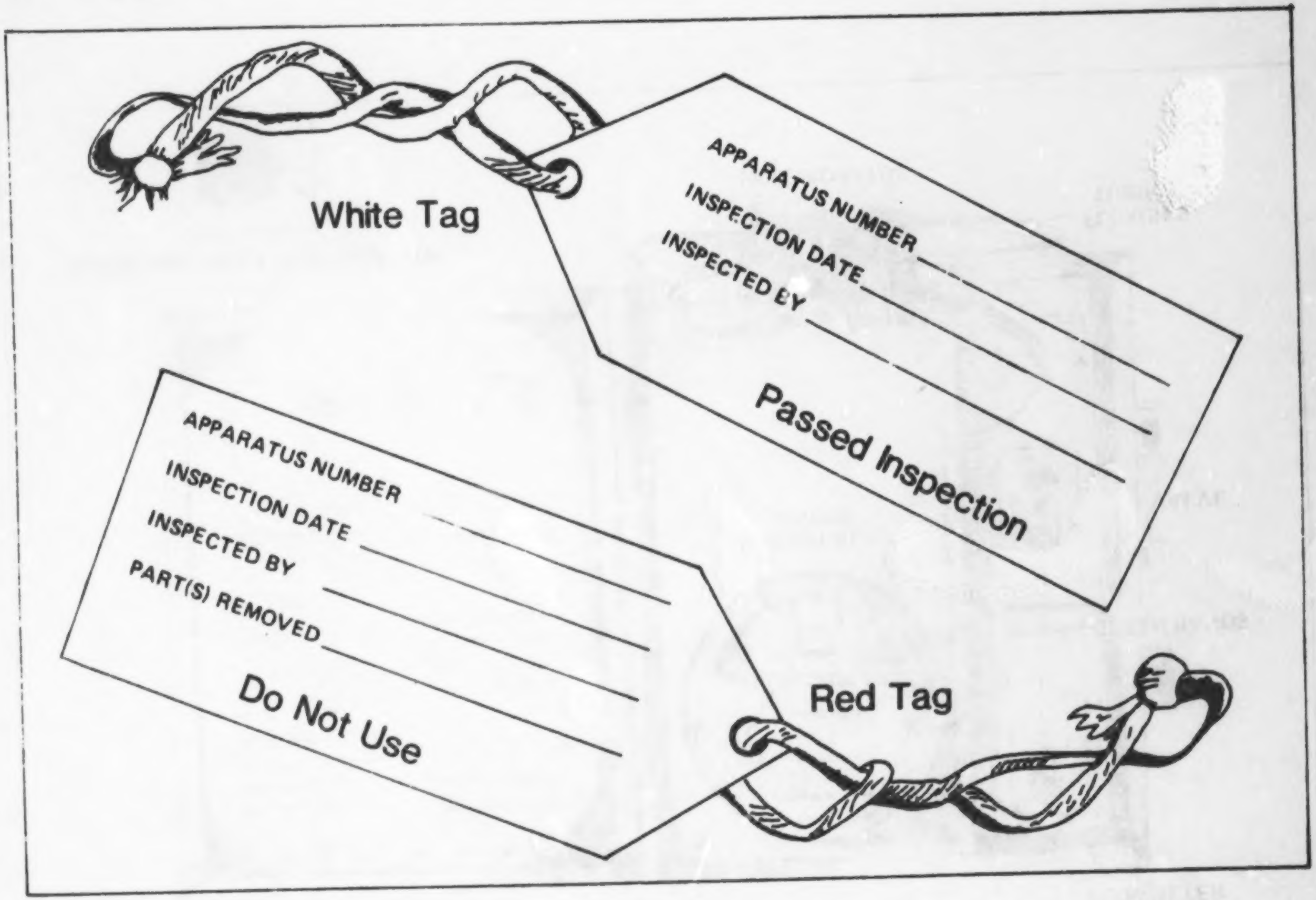
Visual 21
Scott Sample Maintenance Record

Apparatus Type: ______________________ **Serial #** ______________

Apparatus # ______________________________

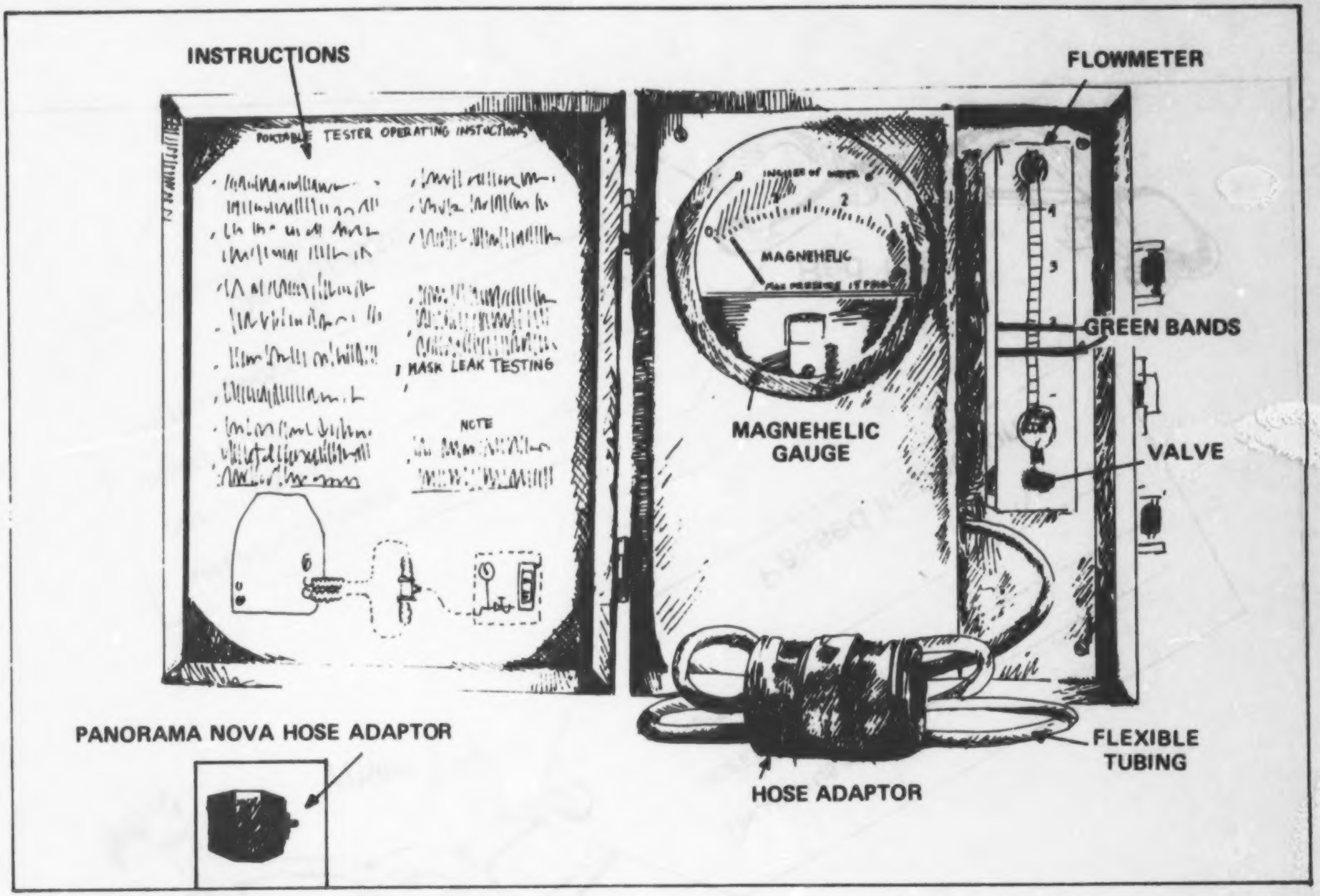
Purchase date ______________________

# Hours Used	Total Hours Used	Date Inspected	Parts Repaired or Replaced	Comments	Inspected By


White Tag
APPARATUS NUMBER
INSPECTION DATE
INSPECTED BY
Passed Inspection
APPARATUS NUMBER
INSPECTION DATE
INSPECTED BY
PART(S) REMOVED
Do Not Use
Red Tag

Visual 22

Sample Tags

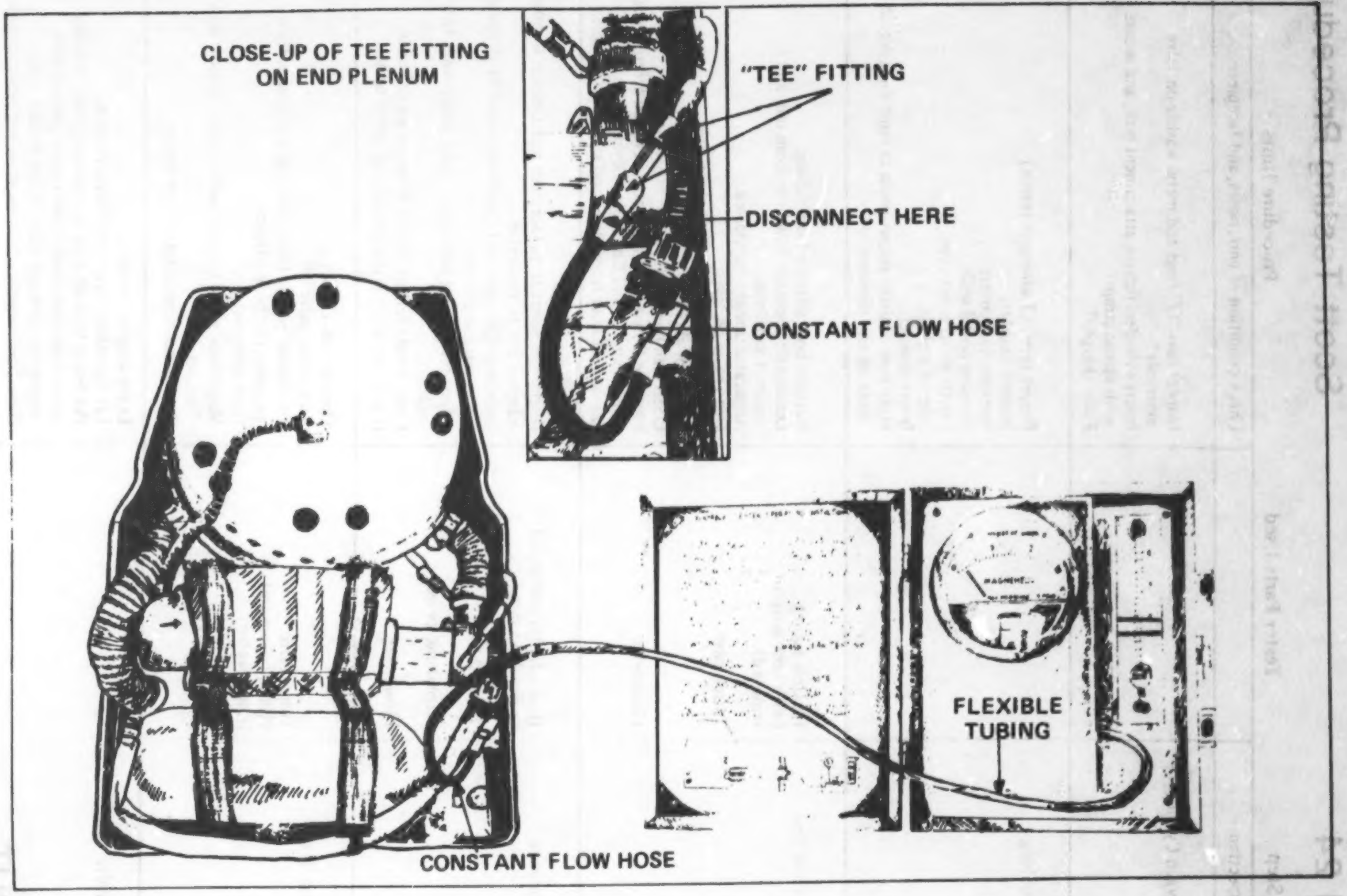

INSTRUCTIONS
PORTABLE TESTER OPERATING INSTRUCTIONS
MASK LEAK TESTING
NOTE
MAGNEHELIC
INCHES OF WATER
FLOWMETER
GREEN BANDS
MAGNEHELIC GAUGE
VALVE
PANORAMA NOVA HOSE ADAPTOR
FLEXIBLE TUBING
HOSE ADAPTOR

Visual 23 Scott Portable Tester

Visual 24

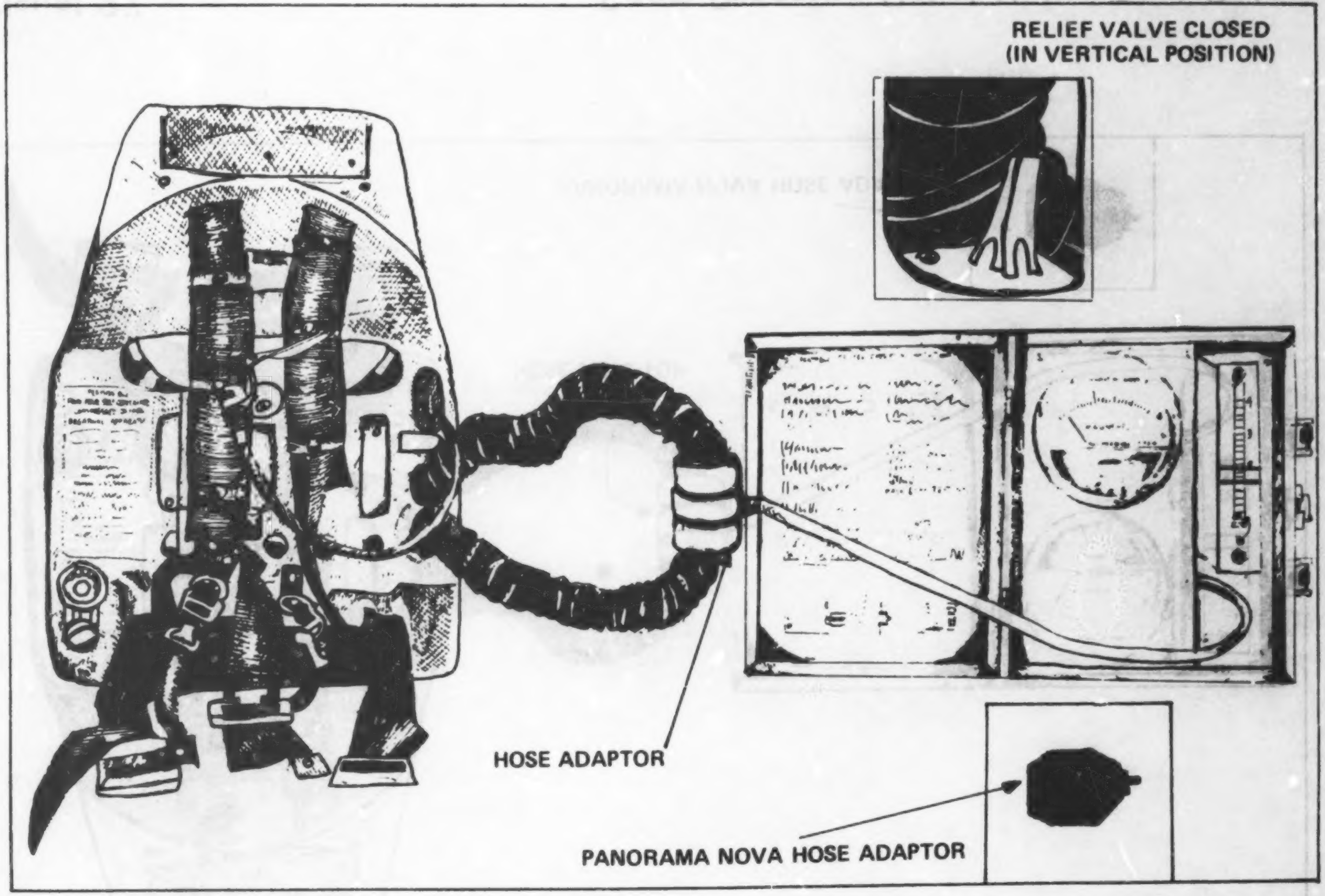
Scott Testing Procedure

Step	Tester Parts Used	Procedure Hints
1. Visual Inspection		Check condition of unit, hoses, and facepiece.
2. Insert Oxygen Cylinder		Inspect two "O" rings and metal washer on valve assembly? Insert cylinder, tighten attachment bolt, and secure with elastic straps? Fully charged?
3. Insert Scrubbing Canister		Proper type? (Training or rescue) Inspect canister. Remove dust covers. Remove portal seals. Center attachment clips. Inspect gaskets. Insert canister. Make sure canister arrows point in same direction as those on end plenums.
4. Constant Flow Test	Flexible tubing (with hose adaptor removed). Tester valve. Flowmeter.	Remove hose adaptor from tubing. Disconnect constant flow hose from unit and connect to tubing. Apparatus upright, supported. Open valve on tester. Open cylinder valve. Check for click. Open mainline valve. Float on flowmeter should stay between green bands. Close mainline and flowmeter valves. Disconnect hose from tester and reconnect to unit.
5. Positive Pressure Test	Hose adaptor connected to flexible tubing. Tester valve. Magnahelic gauge. Flowmeter.	Replace unit cover. Disconnect hoses from facepiece and connect to hose adaptor and to apparatus. Open mainline valve and close relief valve by flipping up to vertical position. Adjust tester valve until Magnahelic gauge reads two inches. Float should remain steady between green bands. If not, check for leaks, repair, and retest unit.
6. Relief Valve Test	Tester valve. Plastic tubing and hose adaptor. Magnahelic gauge.	Open pressure relief valve. Turn tester valve off. Disconnect plastic tubing to relieve pressure, then reconnect to hose adaptor. Open tester valve. Magnahelic gauge should read between ½-inch and 2-inches. Disconnect hose adaptor from tester.
7. Demand Valve Test		Leave adaptor on hoses. Lay apparatus down flat. Remove cover. Put finger through hole in breathing bag cover and press down until metal disc makes contact with plunger on demand valve. Valve should open. If not, disassemble, clean/moisten and retest demand valve.

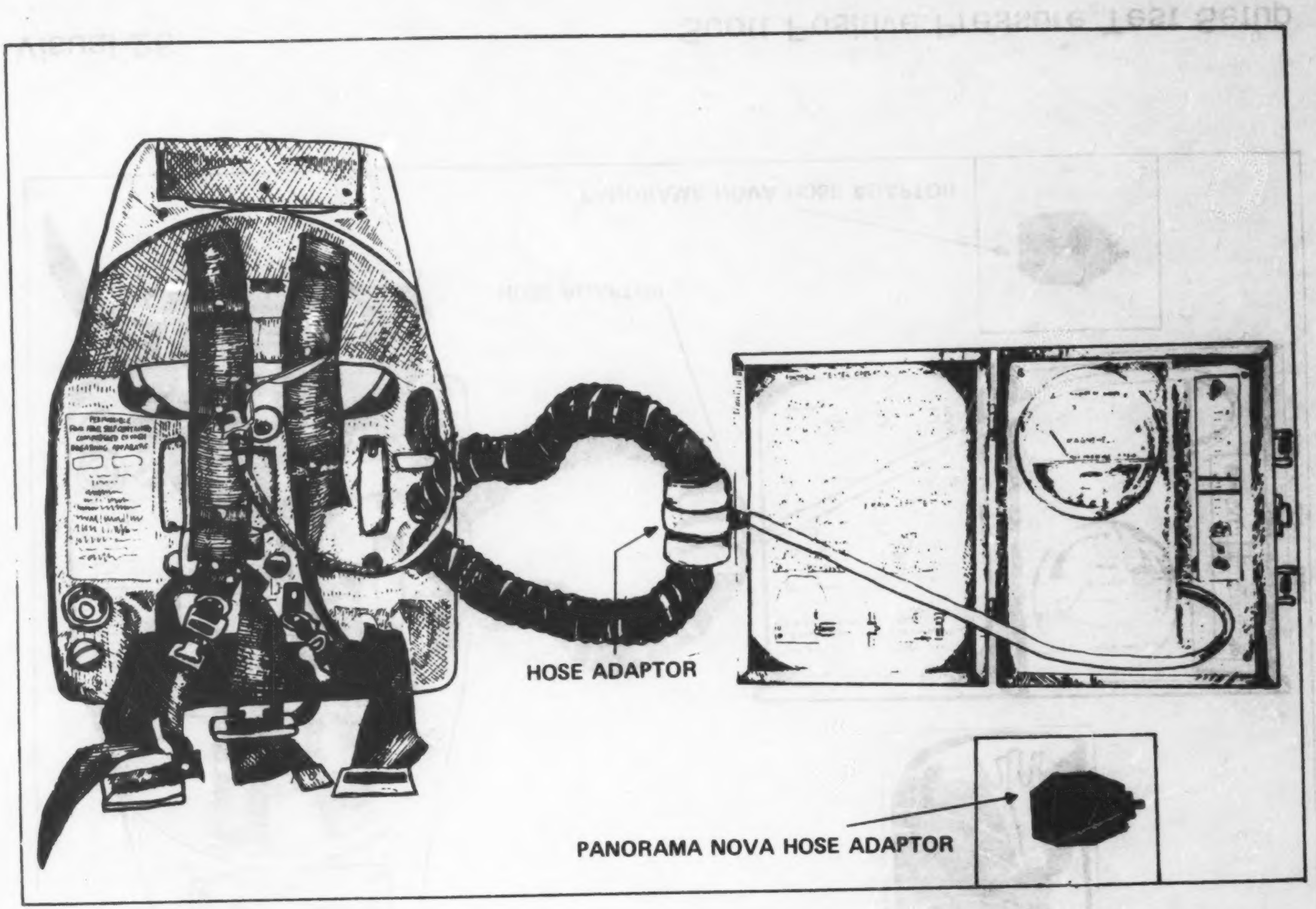

CLOSE-UP OF TEE FITTING ON END PLENUM
"TEE" FITTING
DISCONNECT HERE
CONSTANT FLOW HOSE
FLEXIBLE TUBING
CONSTANT FLOW HOSE

Visual 25

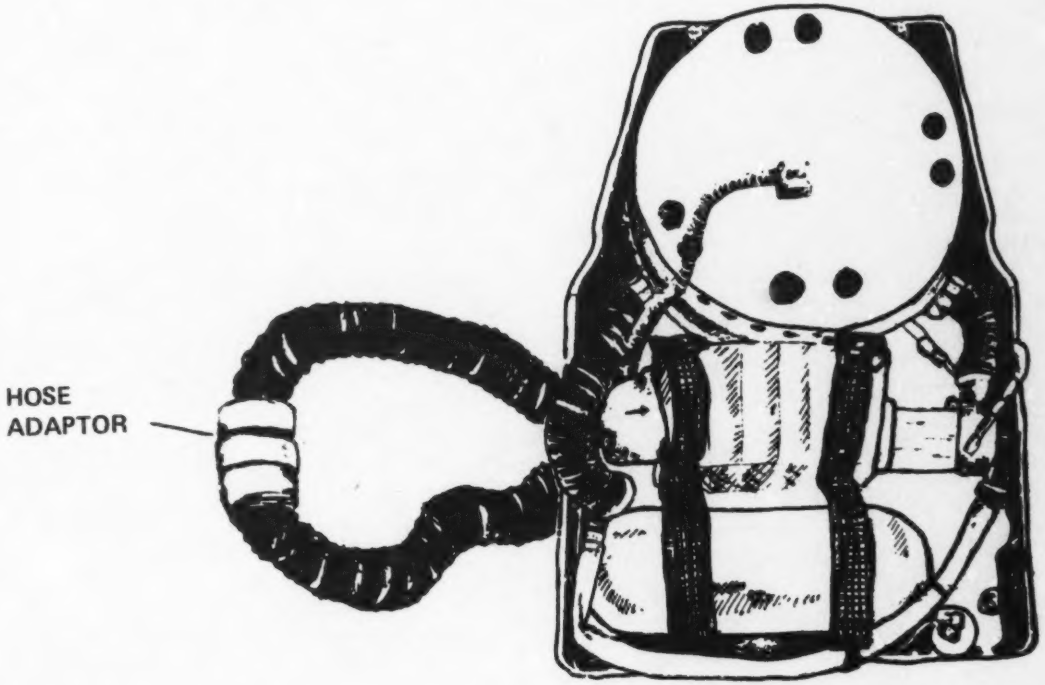
Scott Constant Flow Test Setup


RELIEF VALVE CLOSED (IN VERTICAL POSITION)
HOSE ADAPTOR
PANORAMA NOVA HOSE ADAPTOR

Visual 26 Scott Positive Pressure Test Setup


HOSE ADAPTOR
PANORAMA NOVA HOSE ADAPTOR

Visual 27 Scott Pressure Relief Valve Test Setup


HOSE
ADAPTOR

Visual 28 Demand Valve Test

Demonstration Check 1
PUTTING ON, TAKING OFF THE SCOTT RESCUE-PAK

Person's name ________________________

Instruct each team member to demonstrate for you the proper method of putting on and taking off the Scott Rescue-Pak. Watch closely as the person goes through the demonstration. Use the checklist below to record the performance.

Before putting on the apparatus, the team member should check that each of the following procedures have been completed. If any of the procedures has not been done, they should be completed at this point.

Did the person:

1. Check that the apparatus contains a full (1980 PSI) oxygen cylinder? Yes ___ No ___
2. Make sure there's a fresh CO_2 scrubbing canister in the apparatus? Yes ___ No ___
3. Open the cylinder valve? Yes ___ No ___
4. Listen for the "click" indicating that the alarm has set itself? Yes ___ No ___
5. Check that drain tube is in place? Yes ___ No ___
6. Make sure relief valve shutoff switch is open (in "down" or "flat" position)? Yes ___ No ___

Preparing, Putting On, and Testing the Facepiece

Did the person, in the following order:

1. Visually inspect facepiece? Yes ___ No ___
2. Coat lens with anti-fog? Yes ___ No ___
3. If mask has wiper, lubricate wiper? Yes ___ No ___
4. Attach hoses to facepiece? Yes ___ No ___
5. Prepare facepiece by pulling harness away from mask and fully extending straps? Yes ___ No ___
6. Put on mask correctly, chin first, and make sure web is straight? Yes ___ No ___
7. Tighten straps properly, beginning with pair at bottom and working up? Yes ___ No ___
8. Tighten top strap last, if necessary Yes ___ No ___

9. Seal off exhalation hose and exhale into facepiece, checking to make sure no air leaks out of inhalation valve? Yes ___ No ___
10. Seal off end of inhalation hose and try to inhale, checking to make sure no air enters the facepiece? Yes ___ No ___
11. Remove facepiece and attach hoses to apparatus and to "D" ring on harness? Yes ___ No ___

Putting On the Apparatus

Did the person:

1. Extend right and left shoulder straps? Yes ___ No ___
2. Slip unit onto back correctly and adjust, if necessary? Yes ___ No ___
3. Adjust right and left shoulder straps? Yes ___ No ___
4. Buckle waist belt? Yes ___ No ___
5. Suspend facepiece from neck? Yes ___ No ___
6. Fully open mainline valve? Yes ___ No ___
7. Put on facepiece correctly? Yes ___ No ___
8. Check face-to-facepiece seal? Yes ___ No ___
9. Check remote pressure gauge? Yes ___ No ___
10. Recheck that relief valve shutoff is in the down/open position? Yes ___ No ___
11. Check that bypass valve is operating? Yes ___ No ___

Taking Off the Apparatus

Did the person, in the following order:

1. Remove facepiece correctly? Yes ___ No ___
2. Disconnect breathing hoses from facepiece, if help is available? Yes ___ No ___
3. Close mainline valve? Yes ___ No ___
4. Release chest and waist straps and slip unit off? Yes ___ No ___
5. Disconnect hoses from unit (if not done previously) and from facepiece? Yes ___ No ___
6. Lay unit down flat on a bench or table with cover facing up? Yes ___ No ___
7. Open cover, turn off cylinder valve, and close cover? Yes ___ No ___

Demonstration Check 2

CLEANING AND DISINFECTING

Person's name ______________________________

Instruct each team member to demonstrate for you the correct procedure for cleaning the Scott Rescue-Pak. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance.

Disassembling the Apparatus

Did the person:

1. Remove the cover correctly? Yes ____ No ____
2. Remove the CO_2 scrubbing canister correctly? Yes ____ No ____
3. Dispose of the canister to prevent re-use? Yes ____ No ____
4. Check to be sure cylinder valve is closed? Yes ____ No ____
5. Depress bypass to relieve pressure if indicated on remote reading pressure gauge? Yes ____ No ____
6. Remove the O_2 cylinder and valve assembly correctly? Yes ____ No ____
7. Disconnect the breathing bag inlet hose? Yes ____ No ____
8. Plug breathing hose connection? Yes ____ No ____
9. Tilt apparatus to drain water out drain tube and into container? Yes ____ No ____

Cleansing and Disinfecting

(Note: It may not be necessary for the person to actually wash, rinse, and dry the parts. Have the student "go through the motions," so to speak, telling you how to properly wash, rinse, and dry the parts.)

Did the person:

1. Rinse the breathing hoses (and saliva trap, if present) with clear water? Yes ____ No ____
2. Wash the hoses and facepiece with a brush or cloth using a 5 to 10 percent solution of sodium carbonate? Yes ____ No ____
3. Thoroughly rinse the parts? Yes ____ No ____
4. Prepare a 50 percent solution of water and ethyl alcohol? Yes ____ No ____
5. Properly disinfect breathing bag and drain tube with this solution? Yes ____ No ____
6. Rinse disinfected parts with clean water? Yes ____ No ____

Reassembling the Apparatus

Did the person:

1. Thoroughly dry parts? Yes ____ No____

2. Position fully charged cylinder and valve assembly in Back-Pak Shell and secure? Yes ____ No ____

(Optional: Place new CO_2 scrubbing canister assembly in shell with seals intact?) Yes____ No____

3. Replace dust covers on end plenums? Yes____ No____

4. Place cover assembly on Back-Pak Shell and secure? Yes____ No____

Demonstration Check 3
TESTING PROCEDURE

Person's name ____

Instruct each team member to demonstrate for you the proper method of testing the Scott Rescue-Pak. Watch closely as the person goes through the demonstration. Use the checklist below to record the performance.

Did the person:

Step 1: Visual Inspection

Check for good condition? **Yes ____ No ____**

Step 2: Insert O_2 Cylinder

Inspect 2 "O" rings and washer? **Yes ____ No ____**

Fully charged? **Yes ____ No ____**

Step 3: Insert Scrubbing Canister

Proper type (training or rescue)? **Yes ____ No ____**

Inspect canister? **Yes ____ No ____**

Remove dust covers from end plenums? **Yes ____ No ____**

Remove seals from canister? **Yes ____ No ____**

Center attachment clips? **Yes ____ No ____**

Inspect gaskets? **Yes ____ No ____**

Attach both end plenums and secure canister? **Yes ____ No ____**

Arrows pointed in same direction? **Yes ____ No ____**

Step 4: Constant Flow Test

Disconnect constant flow hose from "tee" fitting? Yes ____ No ____

Connect constant flow hose to flexible tubing on tester? Yes ____ No ____

Open valve on tester flowmeter? Yes ____ No ____

Open cylinder valve and listen for click? Yes ____ No ____

Open mainline valve? Yes ____ No ____

Float on face of flowmeter between two green bands? Yes ____ No ____

Close mainline and flowmeter valves? Yes ____ No ____

Remove flexible tester hose and reconnect constant flow hose? Yes ____ No ____

Step 5: Positive Pressure Leak Test

Replace cover? Yes ____ No ____

Connect breathing hoses to apparatus, but not to facepiece? Yes ____ No ____

Open mainline valve and close relief valve shutoff switch? Yes ____ No ____

Adjust tester valve until Magnahelic gauge reads two inches? Yes ____ No ____

Float between two green bands? Yes ____ No ____

If not, check for leaks and retest? Yes ____ No ____

Step 6: ***Relief Valve Test***

Open relief valve? Yes ___ No ___

Turn needle valve on portable tester to "off?" Yes ___ No ___

Disconnect plastic tube at hose connector to relieve pressure? Yes ___ No ___

Reconnect tube to hose connector adaptor? Yes ___ No ___

Open tester valve? Yes ___ No ___

Pressure on gauge between ½ inch and 2 inches? Yes ___ No ___

Disconnect hose adaptor from tester? Yes ___ No ___

Step 7: ***Demand Valve Test***

Hose adaptor on hoses? Yes ___ No ___

Depress breathing bag diaphragm? Yes ___ No ___

Demand valve opened? Yes ___ No ___

If not, disassemble, clean/moisten and retest? Yes ___ No ___

Suggested Wearing Schedule

The purpose of this wearing schedule is to give new team members a chance to practice wearing an apparatus--breathing, moving, and working with it on. Also they will practice performing team checks.

The three sessions of the wearing schedule are designed to be progressively more demanding. This wearing schedule is provided as a guide. You can tailor it to fit the conditions at your mine site and the needs of your team.

Prior to any practice procedures that involve wearing SCBA, the prospective mine rescue team member should be familiar with the construction, assembly, testing, and care of the apparatus being used, and should have met the physical requirements for mine rescue team membership as outlined in 30 CFR, Part 49.

During the initial training sessions, the instructor should monitor the condition of each member closely. Besides checking each team member's general physical condition, the instructor should be on the lookout for signs of potential trouble like these:

1. Rapid, shallow breathing by trainee (indicates inexperience in breathing with an apparatus)

2. Excessively heavy breathing (indicates trainee is excited)

3. Facepiece fit

   a. Too loose--indicated by:

      (1) Shifting of facepiece during activity
      (2) Failure to maintain facepiece seal

   b. Too tight--indicated by:

      (1) Red marks on face when facepiece is removed
      (2) Trainee complains of headache

4. Excessive use of bypass valve by trainee. If apparatus is functioning properly, this indicates:

   (1) Lack of confidence in apparatus
   (2) Poor physical condition of trainee
   or
   (3) Improper breathing technique

5. Rapid consumption of O_2 supply by trainee. If apparatus is functioning properly, this indicates:

   (1) Lack of confidence in apparatus
   (2) Poor physical condition of trainee
   (3) Excited condition of trainee
   or
   (4) Improper breathing technique

TEAM CHECKS FOR SCOTT

The team should make an initial check when they put on their apparatus and then stop every 15 to 20 minutes thereafter to make checks.

At each rest stop the team member should be asked if he or she is okay and fit to continue the exercise.

A team check should also include the following:

1. Check of pressure gauge

2. Visual check of facepiece seal

3. Check that apparatus harness is properly adjusted and has not moved during the exercise

4. Check that bypass valve operates correctly

During an actual rescue operation the team captain should carry out these checks, and he or she, in turn, should be checked by the co-captain, but during these practice exercises each trainee should be given the opportunity to carry out a check of the other team members. This will ensure that each team member is familiar with the steps and procedures included in a team check.

SESSION 1

It is suggested that the first session be held on the surface. This session should serve primarily to introduce the new trainee to wearing the apparatus. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Walk at normal speed on level ground (for 10 minutes) to allow trainees to become accustomed to the apparatus.

3. **Rest 5 minutes, breathing normally. Check apparatus and condition of team members.**

4. **Walk over obstructed course, or rough terrain, or climb small hills (10-15 minutes).**

5. **Rest 5 minutes, breathing normally. Check apparatus and condition of team members.**

6. **Each carry a 30 to 50 pound weight (a bag of rock dust, sand, fire extinguisher, etc.) for a distance of approximately 200 yards.**

7. **Rest 5 minutes, breathing normally. Check apparatus and condition of team members.**

8. **Walk on level ground until 45 minutes to one hour of apparatus wearing has been completed.**

SESSION 2

It is suggested that this session be held underground if possible. Have the team perform a physically demanding task while under oxygen so they will begin to understand the limitations imposed upon them by self-contained breathing apparatus. Trainees should:

1. **Properly put on and adjust their apparatus and perform an initial team check.**

2. **Select a stopping (or bulkhead) or other point that they can walk to and inspect (traveling should take about 15 to 20 minutes).**

3. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

4. **Perform some physical activity such as loading a mine car with rock dust, sand, timber, etc. or building a stopping (or bulkhead) or other physically demanding activity. Have the team perform team checks every 15 to 20 minutes while doing this.**

5. Return to surface.

SESSION 3 (Apparatus training in smoke and/or further activities without smoke)

During this session it would be helpful to expose the team to smoke so that they can experience working in smoke and wearing an apparatus under conditions of limited visibility.

If your mining operation is such that a smoke bomb can be used safely underground, this is the most desirable situation. If this is not possible, any confined area–old building, trailer, or a structure made of brattice cloth or plastic–can be used as a smoke room.

Only Step 4 of this session is designed for use in smoke. An alternate Step 4 is also supplied if smoke cannot be used.

Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Spend the next 45 minutes to an hour traveling in conditions that approximate the type of conditions they'll encounter in their mine, i.e. climbing ladders, crawling or duck walking in low roof conditions, walking over rough terrain, up and down inclines, etc. Have team stop for team checks every 15 to 20 minutes.

3. Enter smoke area. Before doing this, the team should stop for a team check. Trainees should pay special attention to their facepiece seals to ensure a proper seal–not too loose or too tight.

Procedures that can be stressed and practiced during the team's time in smoke are:

1. Experiencing the disorientation that can occur in heavy smoke.

2. The use of a linkline or lifeline to keep team members together.

3. Following a rail (or a 2 inch x 4 inch for a substitute rail).

4. Feeling and following the rib or side (or wall in a building).

5. Team communications in smoke.

The exercise should be designed so that the team spends no longer than 20 to 30 minutes in smoke. Team should make verbal team checks as necessary and have a complete team check immediately upon leaving the smoke area.

ALTERNATE STEP 4 (If smoke is not used.)

If you are not using smoke, have the team engage in physical activity related to mine rescue, such as carrying a weighted stretcher or stoke's basket, or carrying supplies or objects, such as lumber, timbers, or rolls of brattice. These should be tasks that require more than one person. This activity should take 20-30 minutes. Have team make checks as necessary.

Instructor's Note: This three-session wearing schedule is intended to introduce the trainee to wearing apparatus under a variety of conditions. In annual refresher training the trainees will be performing advanced rescue and recovery procedures while wearing the apparatus.

General Review

Scott Rescue–Pak

Directions: Select the correct answer to each of the following questions.

1. What part of the Scott apparatus absorbs CO_2?

- **a. Breathing bag.**
- **b. Oxygen regulator.**
- **c. Scrubbing canister.**
- **d. Remote pressure gauge.**
- **e. Oxygen cylinder.**

2. Which of the following are limitations of the Scott Rescue-Pak?

- **a. Weight, size, carbon dioxide deficiency.**
- **b. Limited time and lack of warning alarm.**
- **c. Heat buildup within the unit's system and fogging of facepiece.**
- **d. All of the above.**

3. When you insert a canister, you should do all of the following except:

- a. Center the attachment clips on each portal of the canister.
- b. Remove the seals from a fresh canister.
- c. Make sure the seals on the canister are secure.
- d. Secure canister by attaching elastic holding straps to the brackets.
- e. a and c.

4. The bypass valve may be used in all of the following situations except:

- a. The regulator fails to deliver its normal supply of oxygen.
- b. The demand valve fails to supply extra oxygen.
- c. The gauge line rips and is releasing oxygen to the outside.
- d. To check the apparatus when putting it on.

5. When drying a cleaned and disinfected Scott Rescue-Pak, it is suggested that the temperature not exceed:

a. 130° F (54° C).
b. 110° F (43° C).
c. 140° F (60° C).
d. 120° F (49° C).
e. 150° F (66° C).

6. Which of the following correctly describe the procedure for the positive pressure test?

a. The apparatus is completely assembled except for the facepiece and the cover.
b. The gauge needle is at 2 and the float should remain between the two green lines.
c. The gauge needle is at 0 and the float is between the two green lines.
d. a and b.
e. a and c.

7. Which of the following method(s) may be used to fill the Scott oxygen cylinders?

a. Cascade system.
b. High-pressure oxygen pump.
c. Low-pressure oxygen pump.
d. a and b.
e. None of the above.

8. When filling and storing oxygen cylinders, the temperature in the room or area should be about:

a. 80° F (27° C).
b. 65° F (18° C).
c. 75° F (24° C).
d. 70° F (21° C).
e. None of the above.

9. When you insert and secure the scrubbing canister in the apparatus, you should make sure that the arrows on the canister:

a. Are pointed in the opposite direction as the arrows on the end plenums.
b. Are pointed in the same direction as the arrows on the end plenums.
c. Are taken off prior to inserting the canister
d. None of the above.

READEX FICHE

10. Which of the following are functions of the CO_2 scrubbing canister:

    a. To remove carbon dioxide from your exhaled breath so that the air can be recirculated.
    b. The chemicals inside the canister absorb and hold the CO_2, allowing only the purified air to pass out.
    c. Allows some of the heat from the purified air to radiate out of the system into the atmosphere.
    d. a and b.
    e. All of the above.

11. When the automatic alarm on the apparatus sounds for about 15 seconds, approximately what percentage of the oxygen supply remains?

    a. 10 to 15 percent.
    b. 5 to 10 percent.
    c. 30 to 35 percent.
    d. 20 to 25 percent.
    e. 50 percent.

12. If your alarm rings for more than a minute, this would indicate that you have approximately how many minutes of time left under oxygen?

    a. 15 minutes.
    b. 10 minutes.
    c. 5 minutes.
    d. 20 minutes.
    e. None of the above.

13. If the normal supply of oxygen isn't delivered to you because the regulator or demand valve fails, you should:

    a. Turn off the cylinder valve.
    b. Close the relief valve shut-off.
    c. Use the bypass valve to get the oxygen you need.
    d. Close the gauge shut-off valve.
    e. Stay quiet and wait for help.

14. If the mainline and bypass valves fail in the open position, a great deal of oxygen will be wasted. You should:

a. Remove the cover and use your cylinder valve to shutoff and deliver oxygen as needed.

b. Close the relief valve shut-off.

c. Turn off the remote gauge.

d. All of the above.

e. None of the above

General review answers:

1. c
2. c
3. c
4. c
5. d
6. d
7. d
8. d
9. b
10. d
11. d
12. a
13. c
14. a

11

Glossary

compressed oxygen Gaseous oxygen that is contained under pressure.

flowmeter A device used to measure air flow.

hydrostatic test A test performed on oxygen cylinders every 5 years to check the cylinder's elasticity. (Water is pumped into the cylinder to a pressure greater than the cylinder's pressure service rating to measure how much the cylinder expands.)

lifeline Ropeline or cable from communications system that links the team to the fresh air base. It may be used as a manual communications system to the fresh air base (30 *CFR*, Section 49.6(a)(8)).

linkline Line that links team members together. Used in smoke, it is usually a rope about five feet long with rings for each team member to hook onto.

liter Metric unit of measure that is almost equivalent to one quart (1 quart = 0.95 liter).

LPM Liters per minute.

Magnehelic Gauge An instrument used to measure air pressure (calibrated in inches of water).

positive pressure Pressure greater than normal atmospheric pressure, creating a "pushing out" force.

pressure service rating The maximum pressure to which an oxygen cylinder can be filled. (Usually measured in PSI and stamped on the neck of the cylinder.)

PSI Pounds per square inch.

shelf life The length of time that a product can be stored before it begins to deteriorate.

speaking diaphragm A thin flexible disc, usually a part of the facepiece, that vibrates (as in a microphone) to allow transmission of the voice to the outside while wearing the facepiece.

water gauge A means of measuring air pressure expressed in terms related to the height of a column of water. Water gauge is expressed in units known as "inches of water."

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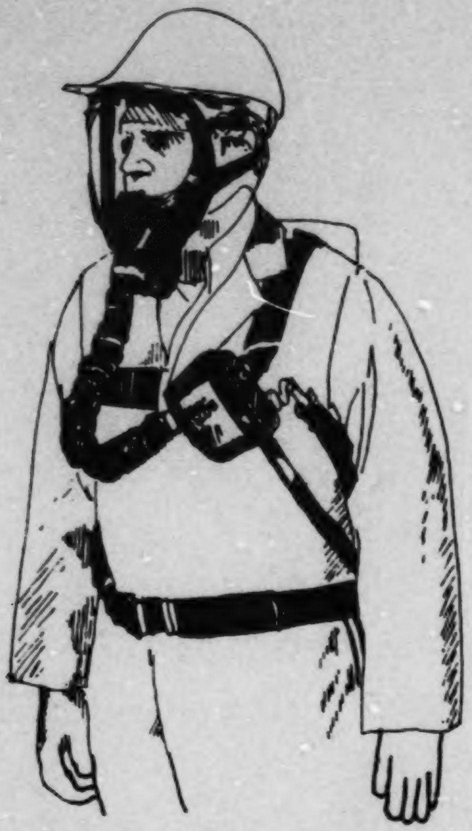
Introduction to Auxiliary Apparatus

Training Module—Initial Mine Rescue

U.S. Department of Labor
Mine Safety and Health Administration
Education and Training Directorate
November 1981

MSHA 2008



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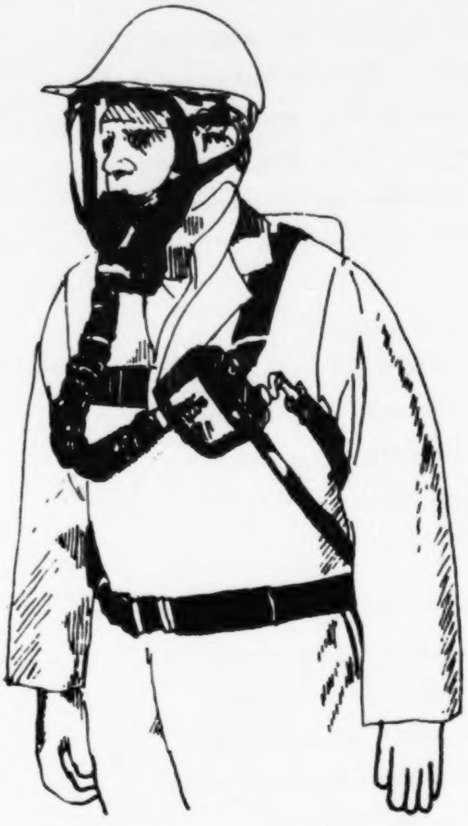

ABOUT THE TRAINING MODULES:

The modules are designed to implement the training of the Nation's mine rescue team members as mandated by Part 49, Subchapter H, Chapter 1, Title 30, Code of Federal Regulations pursuant to the Mine Safety and Health Act of 1977. Each of the modules covers a separate subject in a self-contained unit with suggested handouts and visual material to aid in its presentation. They are designed specifically for the training of underground inexperienced or experienced mine rescue team members.

Training module MSHA 2001, Instructor's Manual for Mine Rescue Training, contains a list of modules in the training program as well as a glossary that can be useful to the instructor.

This program was developed by the Mining Extension Service of West Virginia University for the Mine Safety and Health Administration under United States Bureau of Mines Contract Number JO308002.

Auxiliary Apparatus

Training Module–Initial Mine Rescue

U.S. Department of Labor
Raymond J. Donovan, Secretary

Mine Safety and Health Administration
November 1981

MSHA 2008

Contents

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Course Objectives

Main objective

The mine rescue team member or participant will recognize the basic characteristics, components, and applications of auxiliary self-contained breathing apparatus (ASCBA).

Supportive objectives

The team members will:

1. Identify the Federal regulations governing the use of ASCBA.

2. Identify the various types of ASCBA and their main advantages and disadvantages.

3. Identify the major components of the ASCBA used by the team and demonstrate competence in wearing and maintaining the ASCBA.

Course Materials

Required:

Handouts and visuals from the back of this module
Pencil and paper for each team member
The ASCBA that the team will be using
The manufacturer's information that comes packed with the apparatus

Suggested:

Overhead projector
Equipment for making copies and/or transparencies
Chalkboard

Optional Resources:

Title 30 of the Code of Federal Regulations (30 CFR)

Course Outline

I. **Auxiliary self-contained breathing apparatus (ASCBA)**
   - A. **Definition**
   - B. **Federal regulations regarding use of**

II. **Types of ASCBA**
   - A. **Closed circuit systems**
     - 1. **Brands**
       - a. **Chemox**
       - b. **BioPak**
     - 2. **Advantages/Disadvantages**
   - B. **Open circuit systems**
     - 1. **Demand system**
     - 2. **Pressure demand system**
     - 3. **Brands**
       - a. **MSA AirMask**
       - b. **Scott AirPak**
       - c. **SurvivAir**
       - d. **Globe Guardsman**
       - e. **Siebe Gorman Air Master**
     - 4. **Advantages/Disadvantages**

III. **Suggested outline of instruction for ASCBA**

Instructor Notes

Note: This module is provided as an introduction to auxiliary apparatus. It includes general information and should be followed by specific information (from the manufacturer) concerning the auxiliary apparatus that the team will be using.

An outline is provided near the end of this lecture material to aid you in organizing and presenting the manufacturer's information on each apparatus. If, however, the team is using the Chemox apparatus refer to the separate *Chemox* training module (MSHA 2009).

Also, before you teach this module, you should have already taught the *Introduction to Self-Contained Breathing Apparatus* training module (MSHA 2003), because some of the terminology in this module is explained in the *Introduction to SCBA* module.

Suggested Lecture

AUXILIARY SELF-CONTAINED BREATHING APPARATUS (ASCBA)

Objective 1: The team members will identify the Federal regulations governing the use of ASCBA.

There are some regulations and restrictions regarding the use of auxiliary apparatus. Title 30 of the Code of Federal Regulations (30 CFR) states that the use of auxiliary apparatus is limited in underground mine rescue and recovery operations to situations where the wearer has ready access to fresh air and at least one backup crew wearing regular (primary) approved self-contained breathing apparatus of two hours or longer rating at the fresh air base. So, in order to use the auxiliary apparatus, you must have a backup team in full apparatus and you must be close to fresh air.

Reference: The reference for the above-mentioned regulations is 30 *CFR*, Section 11.3(e).

Objective 2: The team members will identify the various types of ASCBA and their main advantages and disadvantages.

TYPES OF ASCBA

Auxiliary self-contained breathing apparatus can be divided into two categories: closed circuit systems and open circuit systems.

Closed Circuit Systems

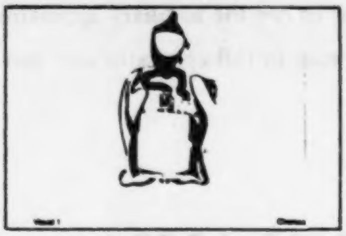
Closed circuit systems, as we discussed before (in the Introduction to Self-Contained Breathing Apparatus module), are units that recirculate the wearer's exhaled air through the apparatus. These units use the same air over and over, removing the carbon dioxide from it and adding fresh oxygen.

There are two closed circuit auxiliary apparatus in use: the Chemox and the BioPak.

Chemox

Visual: Either display a Chemox apparatus if you have one, or refer to "Visual 1" for a drawing of the Chemox.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Note: Some of the terminology which is used in the following sections (e.g., chemical-type apparatus, or compressed air apparatus) is explained in the *Introduction to Self-Contained Breathing Apparatus* training module (MSHA 2003). Refer to that module, if necessary.

The Chemox is a chemical-type apparatus that is worn on your chest. It has a 1-hour service time approval and weighs approximately 13½ pounds. Potassium superoxide is used in this apparatus to produce oxygen and remove carbon dioxide.

The principal components of the Chemox apparatus are:

1. The potassium superoxide canister;
2. A breathing bag to serve as a reservoir of oxygen-enriched air; and
3. The facepiece and breathing hoses.

BioPak

Visual: Either display the BioPak apparatus if you have one, or refer to "Visual 2" for a drawing of the BioPak.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The BioPak is a compressed oxygen apparatus that is worn on your back. There are two models of the BioPak:

1. The BioPak 30P which has a 30-minute approval and weighs 20 pounds; and
2. The BioPak 60P which has a 60-minute approval and weighs 24 pounds.

Note: There is also an older BioPak with a 45-minute approval and a different design than the 30P or 60P. Discuss some of the features of this apparatus here if your team will be using it.

The principal components of the BioPak apparatus are:

1. An oxygen cylinder;
2. A scrubber canister (to remove carbon dioxide);
3. An oxygen pressure reducing valve and an oxygen demand valve for regulating the flow of oxygen from the high-pressure cylinder to the wearer;
4. A breathing chamber to serve as a reservoir of oxygen-enriched air; and
5. The facepiece and breathing hoses.

Advantages/Disadvantages

Both the Chemox and the BioPak apparatus are particularly good for use in confined work spaces because they are light in weight and smaller than your regular apparatus. Also, since the Chemox is worn on your chest, it is particularly well-suited for narrow and obstructed passages and for low coal. Of course, they can only be used in an approved manner, which means you must work close to fresh air (because of the service time) and you must have a backup team with primary apparatus at the fresh air base.

Open Circuit ASCBA

Visual: Refer to "Visual 3" for an example of an open circuit ASCBA.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Open circuit systems are systems that release all your exhaled air (thus the carbon dioxide) to the outside atmosphere and supply you with fresh air to breathe.

There are several brands of open circuit compressed air auxiliary apparatus that have special application to mine rescue work. These apparatus all have a service time approval of approximately 30 minutes and they function in either a demand mode or a pressure demand mode.

A demand system supplies air to you on demand, during inhalation only. A device on the apparatus, called the regulator allows air to flow to the facepiece during inhalation as the wearer needs it.

A pressure demand system provides a continual small supply of air to the facepiece, as well as additional air on demand when you need it during inhalation. A pressure demand system maintains positive pressure within the facepiece at all times.

Note: Positive pressure is pressure greater than the atmospheric pressure. It has a "pushing out" force.

Negative pressure is pressure less than the atmospheric pressure. It has a "sucking in" force.

This positive pressure within the facepiece keeps noxious fumes from entering the facepiece, thus providing you with an extra margin of protection while wearing the facepiece.

On the other hand, with a demand apparatus, there is sometimes negative pressure in the facepiece and if you don't have a good facepiece seal, the outside air could enter the facepiece and contaminate your air supply.

Also, if there is positive pressure within the facepiece, it is slightly easier to inhale because of the pushing effect of the air. However it is also slightly more difficult to exhale because you would be exhaling against the pressure force within the facepiece.

Most of the open circuit apparatus weigh about 30 pounds. The principal components of open circuit apparatus are:

1. An air cylinder;

2. A regulator for reducing the pressure and a demand valve for regulating the flow of air from the high-pressure air cylinder to the wearer;

3. The facepiece and inhalation hose; and

4. The exhalation valve for releasing all the exhaled air.

The brands that are currently approved by MSHA and NIOSH for 30-minute use are:

1. MSA AirMask;

2. Scott AirPak;

3. SurvivAir;

4. Globe Guardsman; and

5. Siebe Gorman Air Master.

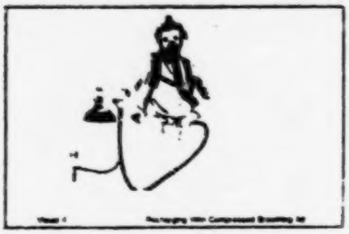
All of these units are available as either demand systems or pressure demand systems.

Advantages/Disadvantages

The main advantages of using open circuit apparatus are:

Visual: Refer to "Visual 4" as you discuss the following advantages.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



1. You can recharge them while wearing them by simply hooking up to a large air cylinder–even in irrespirable air; and
2. You can hook up to a large air cylinder and use it as your air source so that you can wear the apparatus continuously for longer periods of time.

The major disadvantage of using open circuit apparatus is that they, when used by themselves, supply you with only 30 minutes' worth of air, and under extreme conditions (excitement, poor physical health, or heavy exertion), the air supply can be used up in much less than 30 minutes.

SUGGESTED OUTLINE OF INSTRUCTION FOR ASCBA

Objective 3: The team members will identify the major components of the ASCBA used by the team and demonstrate competence in wearing and maintaining the ASCBA.

Note: If your team uses the Chemox apparatus, refer now to the *Chemox* training module (MSHA 2009).

If your team uses one of the other ASCBA, the following outline may be used in conjunction with printed materials from the manufacturer to develop a course of instruction for the apparatus.

Also, you may wish to refer to the training modules on the Chemox or the primary SCBA for further detail on the subject matter to include in the ASCBA course.

I. Describe the ASCBA the team will be using
  A. Air or oxygen?
  B. Closed circuit or open circuit?
  C. Demand or pressure demand?

II. **Define the limitations and applications of the ASCBA**

A. **Limitations**

1. **Service time**
2. **Distance wearer can progress ahead of fresh air**

Note: You will have to add here the specific limitations that pertain to the ASCBA the team will be using (for example, fogging of facepiece, temperature of rebreathed air, etc.).

B. **Applications**

1. **When the ASCBA would normally be used by the mine rescue team**
2. **Who would use the ASCBA**
   - a. **All team members?**
   - b. **Hoist operators, cage tenders?**
   - c. **Survivors coming out of mine?**

III. **Describe the major parts of the apparatus and define their function**

Note: Be sure to emphasize the safety features of the team's ASCBA as well as the manually operated valves.

IV. **Describe the breathing circuit of the apparatus**

Note: In describing the breathing circuit, explain how fresh air or oxygen circulates within the apparatus. Also, in a closed circuit system, be sure to describe how the exhaled air recirculates, leaves behind the carbon dioxide, and mixes with fresh oxygen before it is rebreathed.

V. **Have trainees:**

A. Prepare apparatus for use
B. Perform necessary inspections and tests
C. Put on apparatus
D. Test facepiece seal and functioning of valves
E. Wear apparatus for the length of its service time

Note: It is recommended that while wearing the apparatus, the team members should perform an activity or duty much like they would be involved in under actual emergency conditions.

VI. Describe the care and maintenance of the apparatus

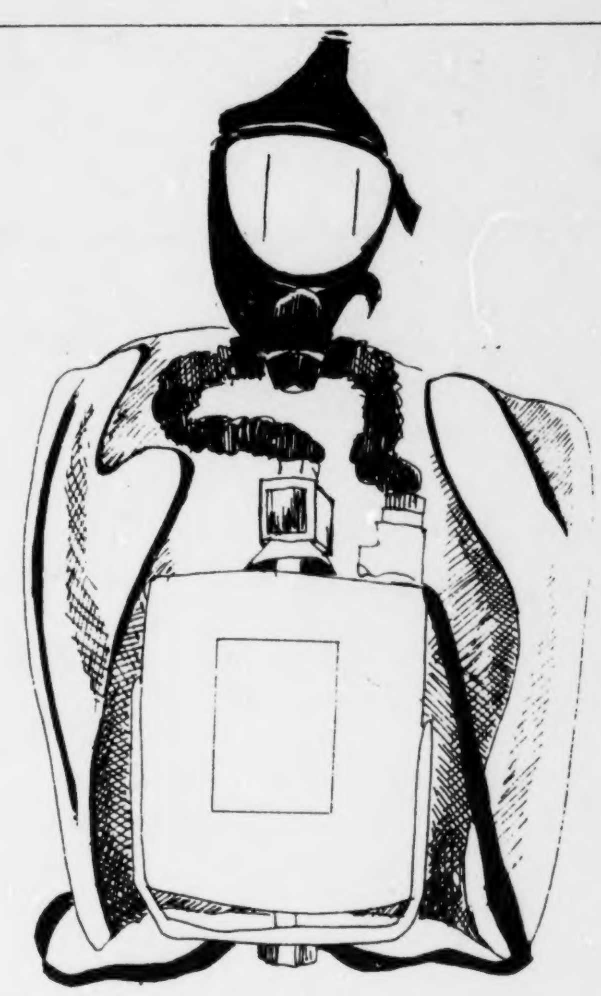
Note: Depending on how your training program is set up, the team members may or may not be responsible for maintaining their own apparatus and keeping records. You may leave out information in the next sections that doesn't apply to your program. However, it's important for all the team members to know what the law says with regard to inspection and recordkeeping.

Note: Refer to the manufacturer's recommendations for the specific care and maintenance of the team's ASCBA.

A. Cleaning and disinfecting the apparatus after use
B. Filling oxygen/air cylinders
C. Periodic inspections
D. Replacement of worn or defective parts

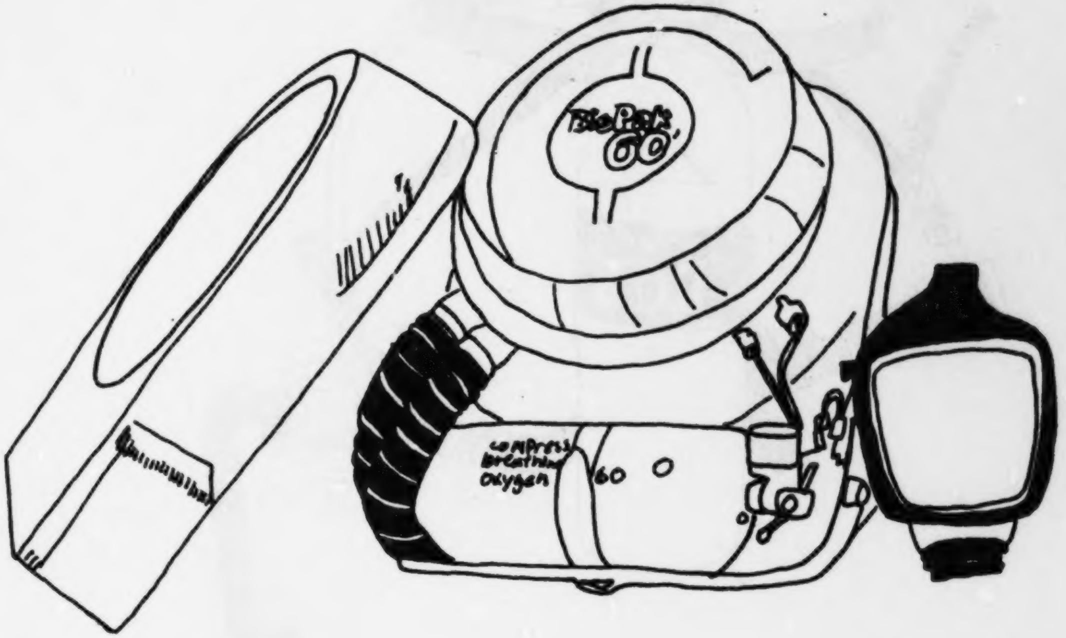
VII. Recordkeeping
   - A. Required testing records
   - B. Maintenance records
   - C. Tagging the apparatus

Note: You may wish to refer to any of the primary apparatus modules for suggested recordkeeping forms. You can adapt these for use with the team's ASCBA.



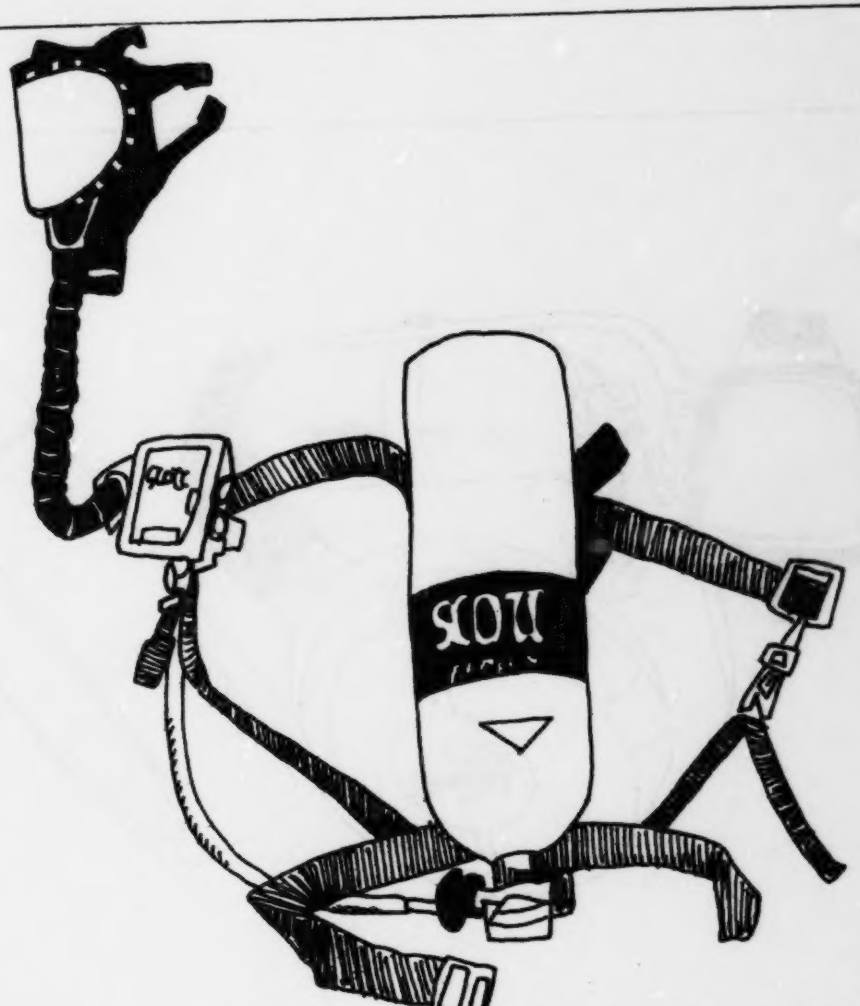
Visual 1

Chemox


BioPak 60
compress breathing oxygen
60

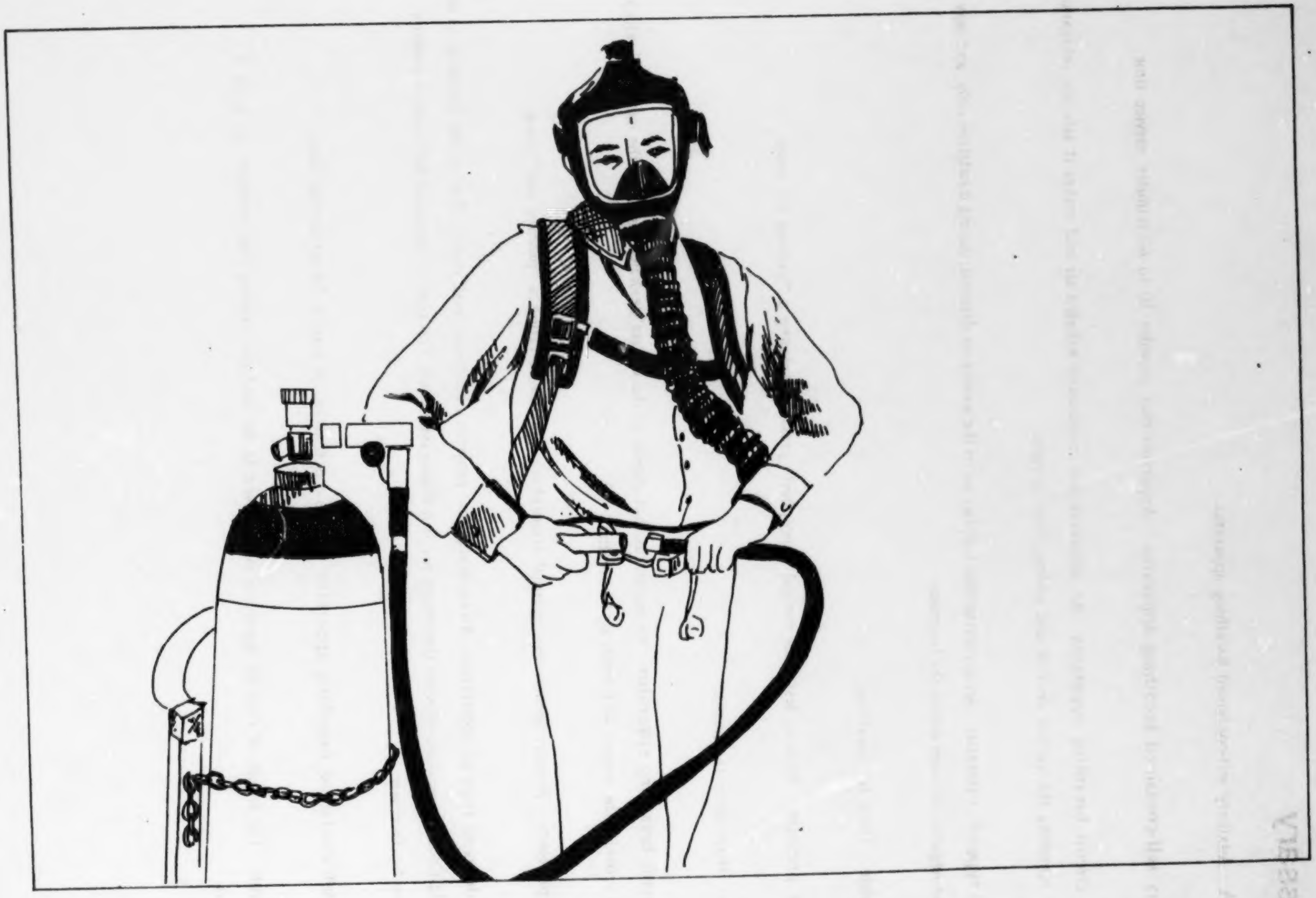
Visual 2

BioPak 60P



Visual 3

Open Circuit ASCBA



Visual 4 **Recharging With Compressed Breathing Air**

Glossary

ASCBA Auxiliary self-contained breathing apparatus.

auxiliary self-contained breathing apparatus Apparatus that provides 30 to 60 minutes' service time.

closed circuit breathing apparatus An apparatus that recirculates exhaled air and makes it safe for rebreathing by removing the carbon dioxide and adding fresh oxygen.

demand type of apparatus An apparatus that supplies air to the wearer on demand, during inhalation only, and may have negative pressure within the facepiece.

irrespirable Unfit for breathing.

negative pressure Pressure less than normal atmospheric pressure, creating a "sucking in" force.

noxious Harmful to the health.

open circuit breathing apparatus An apparatus that expels all the wearer's exhaled air (thus the carbon dioxide) and provides the wearer with fresh air to breathe.

positive pressure Pressure greater than normal atmospheric pressure, creating a "pushing out" force.

pressure demand type of apparatus An apparatus that provides a continual small supply of air to the facepiece, as well as additional air on demand when the wearer needs it during inhalation. This type of apparatus has positive pressure within the facepiece.

primary self-contained breathing apparatus Apparatus that has at least a 2-hour service time.

service time The length of time an apparatus is approved to be used per wearing (for example: ½, 2, or 4 hours).

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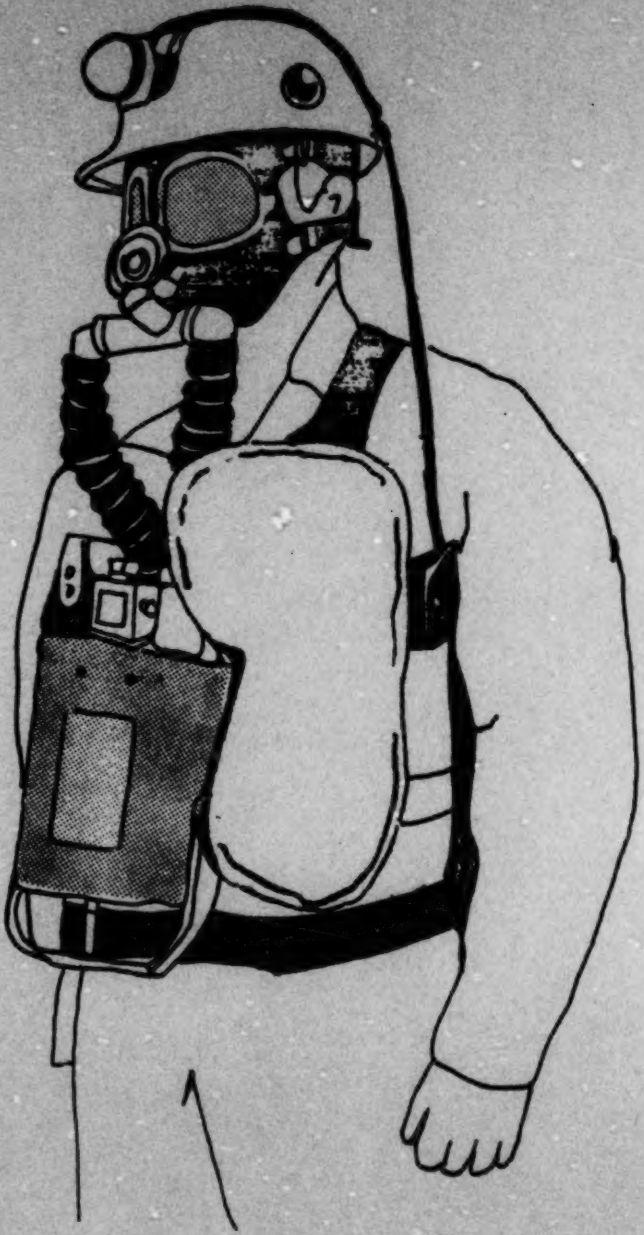
Chemox Auxiliary Self-Contained Breathing Apparatus

Training Module—Initial Mine Rescue

U.S. Department of Labor
Mine Safety and Health Administration
Education and Training Directorate
November 1981

MSHA 2009



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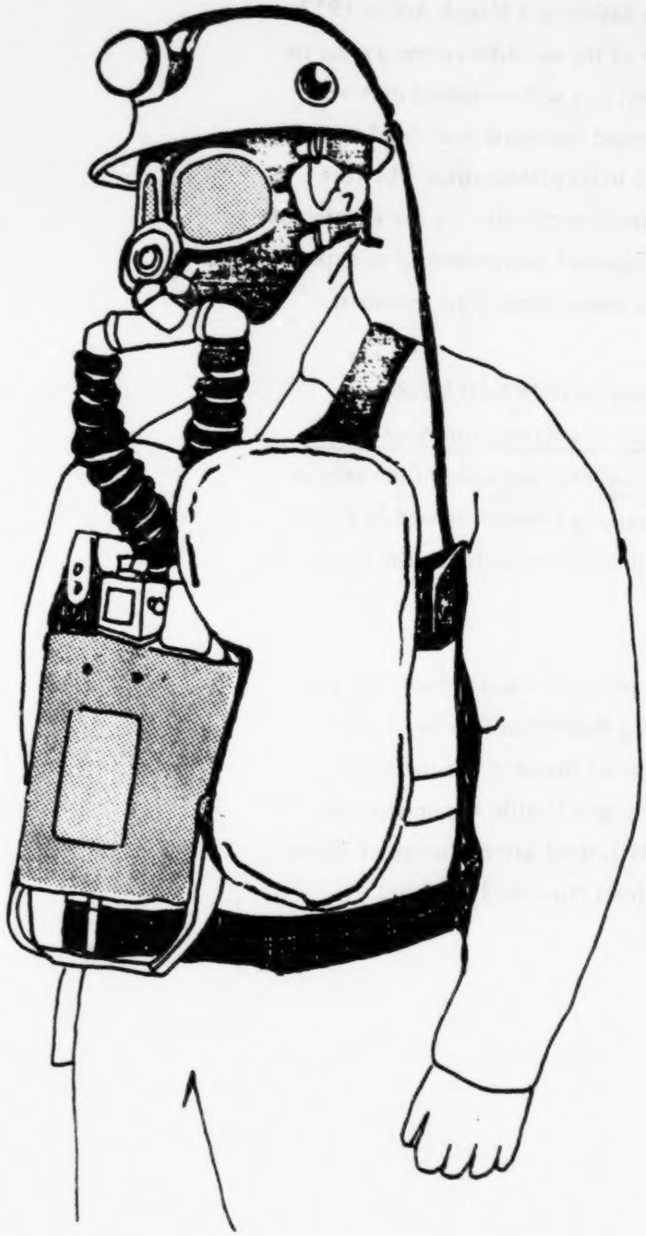

ABOUT THE TRAINING MODULES:

The modules are designed to implement the training of the Nation's mine rescue team members as mandated by Part 49, Subchapter H, Chapter I, Title 30, Code of Federal Regulations pursuant to the Mine Safety and Health Act of 1977. Each of the modules covers a separate subject in a self-contained unit with suggested handouts and visual material to aid in its presentation. They are designed specifically for the training of underground inexperienced or experienced mine rescue team members.

Training module MSHA 2001, Instructor's Manual for Mine Rescue Training, contains a list of modules in the training program as well as a glossary that can be useful to the instructor.

This program was developed by the Mining Extension Service of West Virginia University for the Mine Safety and Health Administration under United States Bureau of Mines Contract Number JO308002.

Chemox Auxiliary Self-Contained Breathing Apparatus

Training Module—Initial Mine Rescue

U.S. Department of Labor
Raymond J. Donovan, Secretary

Mine Safety and Health Administration
November 1981

MSHA 2009

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Course Objectives

Main objective

The mine rescue team members will be able to use and maintain the Chemox auxiliary self-contained breathing apparatus.

Supportive objectives

The team members will:

1. Describe the Chemox one-hour auxiliary self-contained breathing apparatus.

2. List the major parts of the Chemox and describe the function of these parts:
    a. Breastplate and canister holder
    b. Harness
    c. Facepiece and breathing hoses
    d. Canister
    e. Plunger assembly
    f. Breathing bag
    g. Timer

3. Describe the breathing circuit of the Chemox.

4. Put on the apparatus correctly, test it, and prepare it for use.

5. Wear the apparatus and define its limitations when worn.

6. Perform the following recommended scheduled maintenance procedures on the apparatus:
    a. Canister disposal
    b. Apparatus cleaning and disinfecting
    c. Valve inspection and cleaning
    d. General care and maintenance

Course Materials

Required:

Handouts and visuals from the back of this module

Pencil and paper for each team member

Chemox apparatus

Cleaning/disinfecting solution

Anti-fog solution and wiping tissue for facepiece

Suggested:

Overhead projector

Equipment for making transparencies and/or copies

Chalkboard

Optional Resources:

The Chemox manufacturer's information which comes packed with the apparatus

Course Outline

I. The Chemox apparatus description

II. Parts of the Chemox
    A. Breastplate and canister holder
    B. Harness
    C. Facepiece and breathing hoses
        1. Ultravue
        2. All-Vision
    D. Canister
        1. Quick Start
        2. Standard
    E. Plunger assembly
    F. Breathing bag
    G. Timer

III. The breathing circuit

IV. Putting on and testing the apparatus
  A. The facepiece
    1. Inspecting
    2. Putting on
    3. Testing
      a. Inhalation/exhalation valve test
      b. Pressure relief valve test
      c. Exhalation valve/fixed check valve test
      d. Inhalation valve/pressure relief valve test
      e. Exhalation hose
  B. Putting on the apparatus
  C Inserting the canister
  D. Starting the canister
    1. Quick Start
    2. Standard
  E. Testing apparatus functions
  F. Setting the timer

V. Wearing the apparatus
  A. Duration of use
  B. Limitations
  C. Using the pressure relief valve
  D. Canister service life indicators
    1. Lens fogs on inhalation
    2. Wearer finds it difficult to exhale

VI. Apparatus care and maintenance
  A. Canister disposal
  B. Apparatus cleaning and disinfecting
  C. Valve inspection and cleaning
  D. General care and maintenance

VII. **Apparatus inspection**

VIII. **Recordkeeping**

- A. **Inspection records**
- B. **Maintenance records**
- C. **Inspection tags**

Instructor Notes

Note: Throughout this module, the *Visual* notes will recommend that you point out parts on an actual Chemox apparatus. These notes will also refer you to various visuals in the back of the module. You should, if possible, make overhead transparencies of the visuals, sketch them on a chalkboard, or make copies of them to be distributed as handouts to the team members. It is recommended that you use both the actual apparatus *and* the visuals to aid in an overall understanding of the apparatus. However, the use of one or the other will suffice.

Objective 1: The team members will describe the Chemox one-hour auxiliary self-contained breathing apparatus.

Visual: Display a Chemox so that the team can get acquainted with it as you begin the lecture, and/or refer to "Visual 1" for a picture of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Suggested Lecture

THE CHEMOX APPARATUS

The Chemox is an auxiliary self-contained breathing apparatus that you wear on your chest. It is approved for one hour's use as an auxiliary mine rescue apparatus.

Instead of carrying its own oxygen, the Chemox apparatus produces oxygen chemically (hence the name "Chemox") inside a canister attached to the bottom of the unit. Upon contact with moisture in your breath, potassium superoxide in the canister retains carbon dioxide from the air you exhale and produces oxygen for you to breathe.

Because of the Chemox's small size and weight (13½ pounds), and the fact that you wear it on your chest, it's particularly well-suited for rescue work inby fresh air where mine clearances are limited enough to restrict the use of larger, back-worn apparatus.

The Chemox apparatus's one-hour approval rating limits its use. This is because most mine team explorations and rescue efforts take longer than an hour. But the Chemox auxiliary apparatus has advantages, and it can be very useful in certain situations.

Note: Tell the team in what situations the Chemox auxiliary apparatus is used at your mine.

Note: If the apparatus is being used to go into a tank or bin that contains irrespirable air, the person equipped with a Chemox should be attached to a safety lanyard manned by enough people to pull the Chemox operator to safety if necessary.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. When would you be likely to use a Chemox auxiliary apparatus?

   (Answer: For rescue attempts inby fresh air in situations where clearances would not permit the use of a larger back-worn apparatus and/or when the rescue work would not take longer than one hour.)

2. How does the Chemox apparatus supply you with oxygen and remove carbon dioxide from the air you breathe?

   (Answer: By means of a chemical reaction which takes place in the canister.)

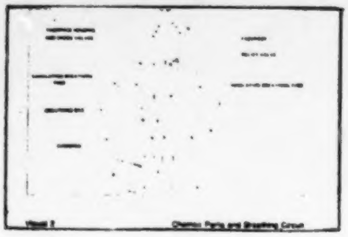
PARTS OF THE CHEMOX

Objective 2: The team members will list the major parts of the Chemox and describe the function of these parts:

1. Breastplate and canister holder
2. Harness
3. Facepiece and breathing hoses
4. Canister
5. Plunger assembly
6. Breathing bag
7. Timer

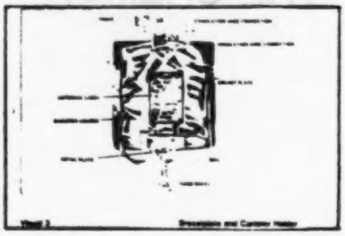
Visual: Point out the following parts on an apparatus and/or refer to "Visual 2" for a picture of the main parts of the apparatus.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Visual: Point out the breastplate and canister holder on the apparatus and/or refer to "Visual 3" for a picture of the breastplate and canister holder.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



Breastplate and Canister Holder

The breastplate and canister holder make up the frame of the apparatus. They are made of sheet steel or aluminum and covered with an insulating material to protect you from heat produced by the apparatus and to provide wearing comfort.

At the bottom of the canister holder is a stirrup-like metal bail with a threaded bar that you tighten against the canister to hold it in place.

Harness

Visual: Point out the harness on an apparatus and/or refer to "Visual 4" for a picture of the harness.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Visual 4
Chemox Harness

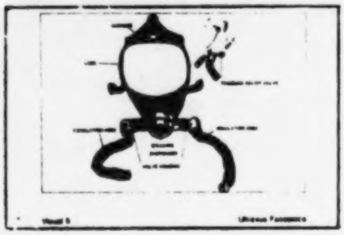
The harness supports the apparatus and holds it in place on your body. It is made of strong cotton webbing ending in snap hooks that connect to "D" rings on the top of the breastplate frame. The harness straps are fitted with metal slides that you can adjust so the apparatus fits you properly. A smaller belt secures the apparatus to your waist.

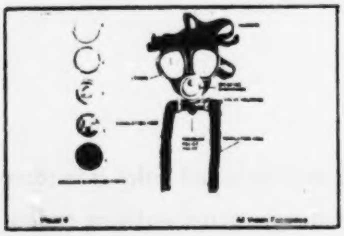
Demonstration: Demonstrate how to fasten and adjust the harness straps. (The team members will learn how to put on the Chemox later on in the lecture.)

Facepiece and Breathing Hoses

Visual: Point out the facepiece and breathing hoses on an apparatus and/or refer to "Visual 5" for a picture of the Ultravue facepiece or "Visual 6" for a picture of the All-Vision facepiece, depending on which one the team uses.

Use this visual as an overhead transparency, chalkboard sketch, or handout.





Note: Two facepieces are approved for use with the Chemox auxiliary apparatus–the Ultravue, (single lens) and the All-Vision (double lens). The information in this section is general and applies to either facepiece. Specific information on each facepiece will be presented later in the lecture.

Your facepiece is made of molded rubber, and is designed in such a way that when its five-strap harness is properly adjusted, it will form a snug fit against your face.

The cylindrical part of the facepiece where the breathing hoses attach is the valve housing. Inside the valve housing are the inhalation and exhalation check valves that keep air flowing in a one-way closed circuit. The inhalation valve lets air flow only toward you, and the exhalation valve lets it flow only away from you.

Visual: Refer again to "Visual 2" as you discuss how the inhalation and exhalation valves channel the air in the closed circuit.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Note: In the Ultravue Facepiece Assembly, the speaking diaphragm is part of the valve housing. On the All-Vision facepiece, the pressure relief valve, along with its check valve, is inside the valve housing. You may wish to mention this here, but it will be presented later in the lecture.

The inhalation hose (on the wearer's left) and the exhalation hose (on the wearer's right) attach to the valve housing with metal clamps, and to the plunger housing and breathing bag by threaded fittings with gaskets. The breathing hoses are made of corrugated rubber.

The perforated or slotted disc on the front of your facepiece is the speaking diaphragm. Inside the protective outer covering is a thin, flexible disc that vibrates in order to transmit your voice to the outside.

The pressure relief valve is a spring-loaded, hand-operated button built into the facepiece. You press it to get rid of excess pressure that builds up in the breathing bag. When you press the button, the excess pressure is let out or "vented" through holes in the valve. Accumulated excess moisture (such as sweat) is also let out. The pressure relief valve is also fitted with a check valve that prevents outside air from leaking in when the relief valve is open. This is known as the fixed check valve.

Note: How and when the pressure relief valve is used will be described in detail later in the lecture.

Note: This valve is also often referred to as the "pressure *release* valve."

Note: This section includes descriptions of both facepieces approved for use with the Chemox auxiliary apparatus. Discuss only the one your team uses.

The Ultravue Facepiece

Your Ultravue facepiece has a single or one-piece lens. Just below the lens is the hard plastic cylindrical valve housing which contains the inhalation and exhalation check valves and the speaking diaphragm. The flexible diaphragm is protected by the slotted valve cap projecting from the front of the facepiece. It attaches to the threaded valve housing with a rubber gasket.

On this facepiece, the pressure relief valve is a separate part located just below the valve housing.

The All-Vision Facepiece

Your All-Vision facepiece has a "split" or double lens. The speaking diaphragm, made up of several parts, is just below the lens. It is important for you to know the diaphragm parts and how they fit together because you will be taking the diaphragm apart and reassembling it as part of regularly scheduled maintenance procedures for your apparatus.

Visual: Point out the diaphragm parts on an apparatus and/or refer again to "Visual 6" for a picture of the diaphragm parts for the All-Vision facepiece.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The valve housing on your facepiece is made of metal and is located below the speaking diaphragm. Inside the valve housing are these parts: the inhalation and exhalation check valves; the pressure relief valve; and the pressure relief check valve. The pressure relief valve is the button that protrudes from the center of the valve housing.

Canister

Visual: Have a canister on hand, and/or refer to "Visual 7" for a picture of the Quick Start canister.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

The canister is a copper-plated steel shell with two layers of potassium superoxide inside it. Between the chemical layers are airspaces which let air flow freely inside the canister and help insure that the moisture in your breath will come into contact with as much of the chemical's surface area as possible.

The canister is secured with an airtight copper foil seal that keeps dust or moisture from coming into contact with the chemical. Once this seal is broken, never reuse the canister, regardless of how much service time you think it has left.

To protect the foil seal during storage, each canister is equipped with a plastic tear-off disc or cap. There's also a rubber gasket under the disc that helps ensure an airtight fit once the canister is in the apparatus.

Note: A Chemox canister can be stored indefinitely if the seal is not broken, the seams of the canister are tight and not deformed, and the plastic cap is still tightly attached to the neck of the canister.

Inside the canister is a copper-plated steel tube that connects to the plunger housing of the apparatus. The air you exhale travels to the bottom of the canister through this tube, forcing air to make a complete pass through the canister from bottom to top.

Visual: Refer again to "Visual 2" for a picture of the tube inside the canister.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Visual: Have a canister on hand, and/or again refer to "Visual 7" for a picture of the Quick Start canister.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Note: A canister produces 10 liters of oxygen (about 10½ quarts).

There are two different canisters available for use with the Chemox auxiliary apparatus—the standard canister and the Quick Start canister. Both share all of the characteristics we've just discussed. But there are some important differences.

One difference is the time it takes to get them operational. It takes 2 to 3 minutes to get the regular canister working versus about 15 seconds for the Quick Start.

This is because you start the regular canister by breathing into it until the moisture in your breath starts the chemical reaction that produces oxygen. On the Quick Start canister, this chemical reaction is aided by heat produced by firing a candle built into the bottom of the canister.

Both canisters must always be started in fresh air.

The Quick Start canister, when started, produces harmless smoke for a few seconds.

Since you must breathe into the apparatus to get the standard canister working, you start it after you put on the facepiece.

Besides starting more quickly, the Quick Start canister also starts easier in cold temperatures (32° F, 0° C) than does the standard canister.

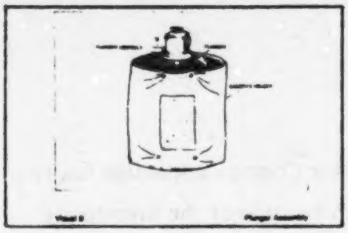
Aside from their approval labels, both the regular and Quick Start canisters look about the same. But you can tell them apart by their color and other features. The Quick Start canister is green and the standard canister is gray.

The Quick Start canister is also easily identified by the raised swivel plate and tab on the bottom right-hand side. Under this swivel plate is the lanyard and candle used to start the canister.

The Plunger Assembly

Visual: Point out the plunger and plunger assembly on an apparatus and/or refer to "Visual 8" for a picture of the plunger assembly.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



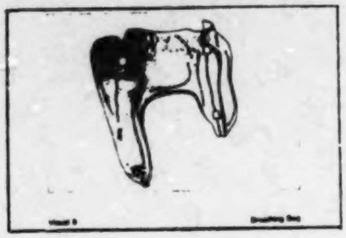
The plunger assembly is the part of the apparatus where the canister connects to the breathing circuit. It is a hollow, spring-loaded stainless steel tube with a pointed end that breaks the canister's foil seal when you put the canister into the holder.

After the seal is broken, the plunger housing seats itself on top of the tube that extends through the center of the canister. The air you breathe out can then enter the tube.

The Breathing Bag

Visual: Point out the breathing bag on an apparatus and/or refer to "Visual 9" for a picture of the breathing bag.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



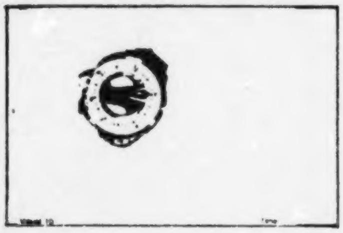
The breathing bag for your Chemox apparatus has two compartments that fit on either side of the breastplate. They look like flexible external lungs. These compartments are made of reinforced rubber, and they're joined together at the top. The inhalation hose connects to the breathing bag on the left-hand side by means of a threaded connection.

The breathing bag holds and cools the oxygen produced by the canister. It holds about 5 liters (or 5½ quarts).

The Timer

Visual: Point out the timer on an apparatus and/or refer to "Visual 10" for a picture of the timer.

Use this visual as an overhead transparency, chalkboard sketch, or handout.



The timer on your Chemox unit lets you know how long your unit has been in service and when to return to fresh air. It's mounted on top of the plunger assembly so you can see it at all times. The timer is calibrated in minutes, and has a maximum setting of 60 minutes.

Because the timer is mechanical and works independently of the apparatus, you must set it each time you use the apparatus. When the preset timer runs out, a warning bell sounds for seven seconds. That's your signal to return to fresh air.

Note: How to set the timer will be explained later in the lecture.

Review questions: Ask the team the following questions. Allow time for them to answer. Then discuss correct answers with them so they fully understand the material covered in this section.

1. What is the duration of use for the canister?

   (Answer: The canister will supply you with enough oxygen for 60 minutes of hard work.)

2. Why is it necessary to have a timer on the apparatus?

   (Answer: The timer lets you know how long the apparatus has been in use and warns you when it's time to return to fresh air.)

3. What does the plunger assembly do?

(Answer: The plunger assembly breaks the seal on the canister and connects the canister to the apparatus so that your exhaled breath can go down the tube inside it.)

4. What does the breathing bag do?

(Answer: It acts as a flexible "lung," holding and cooling the oxygen produced in the canister.)

THE BREATHING CIRCUIT

Objective 3: The team members will describe the breathing circuit of the Chemox.

Visual: Again refer to "Visual 2" for a picture of the breathing circuit.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Your breath travels through the Chemox apparatus on a closed-circuit path that ensures you'll get a constant supply of fresh oxygen. Here's how it works:

When you inhale, oxygen is drawn into a tube located on the left side of the breathing bag. It then goes into the inhalation hose, through the inhalation check valve, into the facepiece, and finally into your mouth and lungs.

When you exhale, the air you breathe out travels through the exhalation hose from the facepiece and check valve. From the exhalation hose, it passes through the tube inside

the canister and then travels up through the potassium superoxide.

Reacting to the moisture in the air you exhale, the potassium superoxide in the canister produces oxygen and absorbs carbon dioxide.

The oxygen produced in the canister then passes out the top of the canister and through a tube that leads to the bottom right side of the breathing bag.

From there, the oxygen travels up the right side of the breathing bag to the top and then over to the left side, cooling as it moves. This oxygen is then drawn into the tube on the left side of the breathing bag where it can be inhaled, and the whole process begins again.

Note: "Left" and "right" as they are used here and throughout the module refer to the wearer's left or right. This will appear to be switched on the visuals because the unit is viewed from the front.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss correct answers with them so they fully understand the material covered in this section.

1. How does air circulate through the Chemox?

   (Answer: When you inhale, oxygen-enriched air is drawn into a tube at the bottom left of the breathing bag. From there, it flows through the inhalation hose to the facepiece.

Exhaled air flows through the exhalation hose and down through the tube in the center of the canister, then up through the potassium superoxide.

This chemical reacts to the heat and moisture in your breath by producing oxygen and absorbing carbon dioxide.

The oxygen-enriched air then flows out of canister top, through a tube in the breathing bag, and into the bottom right of the breathing bag.

From there, it flows to the top right and over to the left side of the breathing bag, cooling as it moves. There, it is ready to be inhaled.)

PUTTING ON AND TESTING THE APPARATUS

Objective 4: The team members will put on the apparatus correctly, test it, and prepare it for use.

Demonstration: As you discuss the following procedures, put on an apparatus or have a team member put it on to demonstrate. Make sure you cover each step thoroughly.

The Facepiece

When you put on the Chemox, you also inspect and adjust the facepiece and start the canister. At the same time, you perform pre-use checks to make sure the apparatus is working properly.

Note: Always put on the apparatus in fresh air.

Inspecting the Facepiece

In order to test the facepiece, you must put it on. But before you do, look the facepiece over carefully to make sure it's in good condition. Be sure to check the valve housing, speaking diaphragm and breathing hoses for tears, cracks, abrasions, or other signs of wear.

Take apart the speaking diaphragm and check to see that the parts are in good condition and that they're put together properly.

Note: The Ultravue facepiece (single-lens) has a one piece speaking diaphragm, so the team members need only check that the diaphragm is in place and the cover plate is on.

The speaking diaphragm in the All-Vision (double lens) has several parts. If your team uses the All-Vision facepiece, refer to the following "Visual 6" note.

Visual: If you are using the All-Vision facepiece, point out the speaking diaphragm parts on the facepiece and/or refer again to "Visual 6" for a picture of the parts.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Bend the facepiece and breathing hoses back and forth to make sure they're flexible.

Inspect the rubber straps on the head harness for signs of wear.

Check the rubber gaskets inside the bottom ends of the breathing hoses (where they attach to the plunger housing and breathing bag). Make sure they're in place and in good condition.

Putting on the Facepiece

Before you connect the breathing hoses to the plunger assembly, put on the facepiece and test it to make sure it's operating properly.

First coat the lens with an anti-fog solution. Pull the harness down over the outside of the mask. Then put your chin into the bottom of the facepiece and pull the harness back up and around your head, making sure that the harness web is straight.

Now tighten the straps by pulling back on each pair at the same time. Start at the bottom with the lowest pair of straps and work your way up.

The facepiece should be comfortable but secure, and have a good face-to-facepiece seal to keep it from leaking around the edges. To test this seal, cover the ends of both breathing hoses with your hands. Then inhale and exhale forcefully several times. If the seal is good, air shouldn't leak into the facepiece when you inhale and it should leak out only when you exhale with great force.

Testing the Facepiece

Once you've put on the mask and you're sure the face-to-facepiece seal is good, you're ready to test the valves inside the facepiece.

Note: The facepiece is not connected to the apparatus during these tests.

Inhalation/Exhalation Valve Test

To check that the inhalation and exhalation valves are working, quickly inhale and exhale several times. You should be able to hear the valves open and close as you breathe through the facepiece.

Note: The rubber valves in the Ultravue facepiece produce a soft flapping noise as they hit against the plastic valve housing. On the All-Vision facepiece, you can hear a distinct clicking noise as the mica-disc valves hit the metal housing.

Pressure Relief Valve Test

Now you're ready to check the pressure relief valve. To do this, simply squeeze the exhalation (right hand) hose shut with your hand. Then exhale into the facepiece until you feel pressure against your face. Press in on the relief valve button. Air should escape through the valve and you should feel the pressure in the mask decrease. Do this several times to make sure the valve is operating properly.

Note: To operate the pressure relief valve on the Ultravue facepiece, support the outer part of the valve with one hand while you press in on the center button with the other.

Exhalation Valve/Fixed Check Valve Test

Both the exhalation check vaive and the pressure relief check valve are designed to let air out, but not in. To test them, cover the bottom end of the inhalation (left hand) hose with your hand. This blocks off the only route by which air should be able to get into the mask. Now inhale deeply. This should have a vacuum-like effect on the mask, causing it to collapse against your face.

Besides letting you know that the exhalation and fixed check valves are closing properly, this also tests the speaking diaphragm, facepiece, and inhalation hose for leaks. Air leaking in at any of these places will keep the mask from collapsing against your face.

Inhalation Valve/Pressure Relief Valve Test

To test the inhalation valve and the pressure relief valve, cover the opening at the bottom of the exhalation hose with your hand and exhale into the facepiece. Since you've blocked the air's normal route out, (through the exhalation hose) it should escape only around the edges of the facepiece. No air should escape from the pressure relief valve or from the inhalation valve.

Exhalation Hose Test

To test the exhalation hose, take off the facepiece and blow forcefully into the bottom end of the hose. If the valve is working properly, it should let air move only away from the facepiece. It should be impossible for you to blow air into it. This also tests the exhalation hose for leaks.

Putting on the Apparatus

Once you've tested the facepiece, take it off and attach the breathing hoses to the threaded connections on the plunger assembly and breathing bag. Then unfasten the harness straps and straighten them out.

To put on the apparatus, pick it up by the plunger housing and support the apparatus, the facepiece, and the hoses with one hand and arm.

With the other hand, grasp the large "D" ring at the center of the harness and slip your head through the opening formed by the junction of the two large harness straps. Drape the facepiece and hoses over your shoulder.

Support the apparatus on your chest with one hand, and reach the other hand behind you and grasp the end of one of the web straps. Fasten the snap hook on the end of the strap onto the "D" ring at the top of the breastplate. Repeat this for the other side, snapping the hook of the other strap into the "D" ring on the opposite side of the breastplate.

Once both web straps are hooked up, adjust the metal slides on the straps for a snug fit. When this is complete, the apparatus should be positioned on your chest so that when you put the facepiece on you will be able to move your head freely from side to side.

Finally, adjust the metal slide on the waistbelt and snap the end of it into the "D" ring on the lower side of the breastplate. Tuck in any loose ends.

Inserting the Canister

Now that the apparatus in on, you're ready to insert a canister and start it. Support the facepiece and breathing hoses by draping them over your shoulder.

Be sure to use a fresh canister. Tear off the plastic cap and throw it away, exposing the copper foil seal. Be sure to keep oil, grease, dirt or other materials away from the neck of the canister at all times.

Swing the bail on the canister holder up toward you and insert the canister in the holder with the seal end up and the smooth (label) side out. Push the canister into the holder until the plunger breaks the foil seal.

Now swing the bail down so the handwheel is under the canister and turn the handwheel clockwise until the metal plate fits snugly against the bottom of the canister and the rubber gasket in the canister is tight against the plunger housing.

Starting the Quick Start Canister

Note: Discuss this section only if the team uses the Quick Start canister.

Starting the Quick Start canister is a fairly simple procedure. All you have to do is remove the starting candle cover (located on the bottom right-hand side of the canister) and pull the cord under it.

To remove the candle cover, turn the swivel plate on top of the candle cover a half-turn (180°) so that it sticks out to form a "tab" you can use for leverage. Push down on the swivel plate tab and push the cover toward the center of the canister. The cover will dangle from the lanyard cord.

To fire the canister, just pull the lanyard straight out away from your body. The breathing bag will fill with oxygen within 15 seconds. Remember that some smoke will be produced by firing the Quick Start canister. This should last only a few seconds and is harmless. Once you fire the canister and the breathing bag is full, check the face-to-facepiece seal.

If you follow these steps carefully and the canister doesn't start, you may do one of two things:

1. **Remove the canister, insert a fresh Quick Start canister, and start it in the manner we've just described.**

2. **Leave the Quick Start canister in the holder and start the canister the same way you'd start a standard canister–by breathing into it.**

Note: Tell the team members you will discuss this alternative method of starting the canister next.

Starting the Standard Canister

Note: Discuss this if you use the standard canister or the Quick Start canister. This procedure can be used as a "backup" method if the Quick Start canister fails to fire.

To start the standard canister, you breathe into it until the moisture in your breath starts the chemical reaction in the canister. Here's how it's done:

First, put on the facepiece and check that the face-to-facepiece seal is tight. Because the canister doesn't produce oxygen right away, you can't inhale from it while you're starting it. But you must exhale into the canister to get it started.

So before you inhale, squeeze both hoses shut with one hand. Put one finger of your other hand between your face and the facepiece to break the seal. Then inhale.

Once you've filled your lungs with outside air, release the breathing hoses and the facepiece. Then exhale into the apparatus.

Keep inhaling outside air and exhaling into the canister until the breathing bag is full. Then press in on the pressure relief valve and squeeze your forearms against both sides of the breathing bag to force the air out of it.

When the breathing bag is empty, start the entire process again, beginning with inhaling outside air and exhaling into the canister.

Remember to break the facepiece seal and squeeze both hoses shut each time you inhale, and release them each time you exhale.

You will probably need to fill the breathing bag and empty it three or four times to get the chemical reaction started.

When the canister begins to produce oxygen, it will travel up the inhalation hose creating pressure in the facepiece.

If you start the apparatus in cold weather (below 32° F or 0° C), the moisture in your breath will tend to condense in the apparatus rather than work on the chemicals, so you'll have to repeat the procedure several more times to get it working.

Testing Apparatus Functions

Once the canister is producing oxygen, perform these tests to make sure the apparatus is working properly.

Squeeze the lower end of the inhalation hose shut with your hand. Inhale slowly. Since you've shut off the air's only way into the facepiece, it should collapse against your face. If the mask collapses, you know your face-to-facepiece seal is tight and there are no leaks in the valve housing or upper part of the exhalation hose.

Next, squeeze shut the exhalation hose to block the air's route out of the mask. Inhale and exhale until air begins to leak out around the edges of the mask. The facepiece should be tight enough for you to feel a distinct increase in pressure before it begins to leak. If the facepiece isn't tight enough, adjust it and repeat the test.

Now check the breathing bag to make sure it's fully inflated. Then press the relief valve enough to relieve some of the excess pressure. Be sure you get rid of excess pressure only. You don't want to completely deflate the breathing bag–or waste oxygen.

To test the lower part of the apparatus, squeeze both breathing hoses shut with your hands. Then try to squeeze air out of the breathing bag with your forearms. The breathing bag shouldn't deflate, indicating that the lower part of the apparatus, including the breathing bag, is not leaking.

Setting the Timer

Once your apparatus is working and you've checked it for leaks, you're ready to set the timer. You must always set the timer so that it will allow you enough time to get to fresh air from your farthest point of travel.

Since the timer is mechanical and works independently of the apparatus, you should synchronize it with your watch and check it against your watch every now and then to make sure it's working properly.

To set the timer, first estimate how much time you'll need to return to fresh air when you're as far in the mine as you plan to go. Then subtract that amount from the total amount of breathing protection (60 minutes) your apparatus provides.

For example, set the timer for 60 minutes when the canister is activated. If it takes 10 minutes to arrive at your work site, you should reset the timer for 10 minutes less. This gives you the 10 minutes of oxygen you'll need to return from the work site to fresh air after the bell sounds.

If you are not going to a specific site, set the timer for 60 minutes to completely wind the spring. Then reset the timer to 30 minutes. This insures that you will have enough oxygen (30 minutes) to return after the bell sounds.

When the pointer returns to zero, the bell on the timer will ring for approximately seven seconds. When you hear the bell, return to fresh air immediately.

Demonstration check: Have each team member put on and test the apparatus. Use copies of the *Demonstration Check 1–Putting On and Testing The Chemox Apparatus* form provided with the module to check each team member's performance. Review the results with each team member.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss correct answers with them so they fully understand the material covered in this section.

1. **How do you check that your face-to-facepiece seal is tight?**

   (Answer: Close both breathing hoses with your hands and forcefully inhale and exhale. Air should not leak into the facepiece, and it should leak out around the edges of the mask only when you exhale with considerable pressure.)

2. **How should the apparatus be positioned on your chest?**

   (**Answer**: The apparatus should be positioned on your chest so that when you put the facepiece on, you can move your head freely from side to side and up and down.)

3. **How do you find out whether the valve housing and inhalation hose are free of leaks and the face-to-facepiece seal is tight?**

   (**Answer**: The facepiece should collapse against your face when you squeeze the inhalation hose shut and inhale.)

4. How do you set the timer?

(Answer: Turn the pointer clockwise to the number you have left after subtracting the amount of time you need to return to fresh air.)

WEARING THE APPARATUS

Objective 5: The team members will wear the apparatus and define its limitations when it is worn.

Duration of Use

The Chemox auxiliary apparatus is approved by the U.S. Bureau of Mines as a one-hour unit. This one-hour rating is based on how much oxygen an average person uses while doing hard work.

But how much time you'll have under oxygen will depend on other factors, such as:

1. **How hard you work;**
2. **What kind of physical shape you're in;**
3. **How much your breathing rate increases due to excitement, fear, or other emotional states;**
4. **How much training and/or practice you've had with the Chemox or other breathing apparatus;**
5. **What kind of condition your apparatus is in.**

The harder you work, the faster you breathe. Naturally you'll consume more oxygen when you're working hard. If you're in poor physical condition, you'll begin to puff and pant sooner (and use up oxygen faster) than someone who is in good condition.

Excitement, fear, and other emotional states also cause you to breathe more quickly and consequently use up your oxygen faster than you do when you're calm.

The more training you've had with the Chemox or any other breathing apparatus, the easier it will be for you to pace yourself and monitor your oxygen consumption so you can control it.

The condition of your apparatus can also determine how much time you'll have under oxygen. You can depend on a properly tested and well-maintained apparatus. But a tiny leak or simple malfunction can cost you precious seconds–or even minutes–of breathing protection.

Limitations

The Chemox apparatus, like any other breathing apparatus, has its limitations. There are things it cannot do and special precautions you should take when you're working with it. Being aware of your unit's limitations can significantly affect how well you do your job.

The most obvious Chemox limitation has to do with time. Since Chemox is a one-hour duration apparatus, its use is limited to activities that can be accomplished in less than one hour's time. Because of the time limitation, the Chemox may be used only as an auxiliary apparatus.

Note: For more information on uses of auxiliary apparatus, see the *Introduction to Auxiliary Apparatus* training module (MSHA 2008).

Here are some other limitations of the Chemox apparatus:

1. **It does not protect you from toxic gases that are absorbed through your skin;**
2. **It won't provide you with protection from repeated exposures to petroleum-based fumes which may penetrate the rubber parts of the breathing bag, hoses, or facepiece;**
3. **Because of the chemical reaction going on inside the canister (and due to the firing candle, if you use the Quick Start canister), the canister gets hot. Never touch the canister while it's in use, and always put on a glove or other protective covering when you remove the canister from the unit.**

Using the Pressure Relief Valve

The Chemox apparatus is designed to provide you with enough oxygen to sustain you for 60 minutes of hard work. If you're not working very hard or if you don't use all the oxygen the unit provides for some other reason, excess pressure will build up in the apparatus. As a result, the breathing bag will become over-inflated and it will become hard for you to exhale. Air may escape around the edges of the mask.

Note: Difficulty in exhalation can also be due to canister resistance. This will be discussed in the next section.

When this happens, check the breathing bag to make sure it's fully inflated. Then press in on the pressure relief valve built into your facepiece. This will let out (vent) some of the excess pressure and trapped moisture. When you use the valve, take care to press it only long enough to relieve some of the excess pressure and make it easier for you to exhale. Using it more than that wastes oxygen.

Canister Service Life Indicators

The warning bell on your apparatus is one signal that the oxygen-producing chemical in the canister is almost expended. There are also two other ways to tell when the canister is nearing the end of its service life. Normally, these signs won't appear until after you've used the apparatus for an hour. However, if you are working extremely hard, there is a chance you'll use the canister faster than that.

Here are two signs that your canister is nearing the end of its service life:

1. The lens fogs when you inhale;

   Heat and moisture in your breath normally cause the lens to fog up while you're wearing the Chemox apparatus. This fog usually clears up when you inhale. But if your lens does not clear up when you inhale, that means that the chemical in the canister is nearly expended and that the canister is nearing the end of its service life.

2. It becomes difficult for you to exhale;

This is known as "canister resistance" and it's not to be confused with excess pressure in the system, even though both make it difficult to exhale.

The way to tell the two apart is to check that the breathing bag is inflated and operate the pressure relief valve when it becomes difficult to exhale. If that doesn't remedy the situation, you'll know that the difficulty is not due to a buildup of pressure within the system. It is canister resistance—an indication to you that your canister is almost expended.

If either of these indications appear while you're wearing the apparatus, return to fresh air immediately.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. Why is the Chemox not recommended for use in mine rescue and recovery work except as an auxiliary apparatus?

   (Answer: The Chemox is used in rescue work only as an auxiliary apparatus because it provides only 60 minutes of breathing protection, so it may be used only for tasks that take less than one hour's time. Most rescue and/or recovery operations take longer than that.)

2. What indicates excessive pressure in the apparatus?

(Answer: When there is too much pressure in the apparatus, it will become difficult for you to exhale and air may escape around the edges of the mask.)

3. **How do you release excess pressure and accumulated moisture from the apparatus?**

   (Answer: First, check that the breathing bag is fully inflated. Then press the button on the pressure relief valve located on the facepiece. Be sure to release *only* excess pressure.)

4. **Besides the timer, what other ways can you tell what your canister is nearing the end of its service life?**

   (Answer: The facepiece fogs when you inhale and/or you find it difficult to exhale and operating the pressure relief valve doesn't relieve the pressure.)

APPARATUS CARE AND MAINTENANCE

Objective 6: The team members will perform the following recommended scheduled maintenance procedures on the apparatus:

1. Canister disposal
2. Apparatus cleaning and disinfecting
3. Valve inspection and cleaning
4. General care and maintenance

Demonstration: As you discuss these care and maintenance procedures, demonstrate how to do them.

Canister Disposal

You must remove the canister from the apparatus after each use. The canister may still be hot due to the chemical reaction taking place inside it, so always use a glove or other covering to protect your hand when you remove the canister from the apparatus.

To take the canister out, turn the handwheel counter-clockwise so that the metal plate moves down. Support the canister with your hand, swing the bail up toward you, and slide the canister out into your hand.

Before you throw away the canister, you must eliminate any oxygen that might remain trapped inside it. Pure oxygen supports combustion, so keep the used canister away from oils, greases, and any type of flame while you perform the following procedure:

Note: Because of the fire hazards involved, *never* do this underground.

First, take the canister above ground. Then, with a non-sparking tool, punch small holes (about ¼ inch in diameter or less) in the front, back, and bottom of the canister.

Once you've punched holes in it, put the canister in a bucket of clean water. There should be enough water in the bucket to cover the canister to a depth of at least three inches. The oxygen inside the canister will bubble out into the water.

When the bubbling stops, carefully pour the water down a drain. Take care not to splash the water or get any on you because it can cause chemical burns. Then throw away the canister.

Cleaning and Disinfecting

You should clean and disinfect the facepiece and breathing hose assembly after each use. To do this, first disconnect the assembly from the rest of the apparatus by unscrewing the hoses from the plunger housing. Then dip the equipment in a sterilizing solution and scrub it gently with a soft brush. Rinse the hoses and facepiece in clear warm water (about 120° F, 43° C) and let them air dry.

Valve Inspection and Cleaning

Inspect the inhalation and exhalation valves every now and then to see if they need to be cleaned or replaced. To remove them, unscrew the bolts on the clamps that hold the facepiece and breathing hoses together. Then release the clamps, remove the breathing hoses, and slide the valves out.

If they need cleaning, immerse the valves in a sterilizing solution. Take care not to remove the valves from their seals while you're cleaning them as this will make it difficult to reassemble them.

After you clean the valves, dry them completely. Then slide each valve assembly back into the side of the facepiece from which you removed it. To make it easier to replace them correctly, the valve assemblies are equipped with slots and grooves that fit into one another.

General Care and Maintenance

Periodically check the plunger and plunger housing to make sure they're clean. Push the plunger up and down several times to make sure it moves freely.

If a part of the apparatus shows signs of wear or fails to operate properly, replace it.

If the apparatus is damaged, send it to the manufacturer to be repaired.

When it's not being used, keep the apparatus in its carrying case. Store canisters in a dry place.

Demonstration check: Have each team member remove the facepiece and breathing hose assembly (including check valves), disinfect and reassemble them, and store the apparatus. Use copies of the *Demonstration Check 2–Care and Maintenance* form provided with the module to check each team member's performance. Review the results with each team member.

Review questions: Ask the team members the following questions. Allow time for them to answer. Then discuss the correct answers with them so they fully understand the material covered in this section.

1. **How do you properly dispose of a used Chemox canister?**

   (Answer: Remove canister from apparatus and:

   a. **Punch small holes in the front, back, and bottom of the canister.**
   b. **Place pierced canister in a bucket of clear water (enough to cover it to a depth of 3 inches).**
   c. Allow the oxygen to bubble out of the canister. Wait for it to stop.
   d. Pour the bucket of water down a drain, taking care not to splash it on yourself.
   e. Throw away the canister.)

2. How do you clean and disinfect the facepiece and breathing hoses?

   (Answer: Disconnect hoses from the plunger assembly. Dip in sanitizing solution, scrub with soft brush, and air dry. Remove and clean the valves periodically. Slide them out by removing clamps on the breathing hoses. Be sure to put each valve back in the side from which you removed it.)

APPARATUS INSPECTION

Note: Depending on how your training program is set up, the team members may or may not be responsible for inspecting their own apparatus and keeping records. You may leave out information in the next sections that doesn't apply to your program. However, it is important for all the team members to know what the law says with regard to inspection and recordkeeping.

As you have seen so far, the Chemox is a fairly simple breathing apparatus. But there are parts that can wear out or fail to work properly. So in addition to cleaning and maintaining the Chemox before and after you wear it, you must also inspect it regularly.

Specifically, this means that the apparatus must be inspected on a routine basis once every 30 days.

Reference: The reference for the 30-day testing is *30 CFR*, Section 49.6(b).

You should also inspect the apparatus after it's been transported from one place to another. A trip on a bumpy road could loosen couplings or otherwise cause the unit to malfunction.

Be sure to inspect the apparatus before you wear it for actual rescue work. It may be an emergency and you may think you don't have enough time to inspect it, but you have to make the time. Once you're in the mine, your life depends on how well your apparatus functions.

Once you're experienced with the inspection procedure, you should be able to run through it quickly and accurately.

RECORDKEEPING

Keeping records of tests and repairs made on your apparatus is an important means of ensuring that your unit is always dependable. Accurate, well-kept records can tell you at a glance the condition of your unit. When kept over long periods of time, records let you in on your unit's "weaknesses" and help you spot minor trouble areas that could turn into major malfunctions. Records also provide you with a basis for developing a replacement schedule for expendable parts.

Inspection Records

Visual: Refer to "Visual 11" for a sample inspection form.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

Federal law requires that you keep an accurate record of each inspection and test performed on the apparatus. This record must be kept at the mine for a period of one year.

Reference: The reference for testing records is *30 CFR*, Section 49.6(b).

This record, which may be designed as a checklist, should include all inspections and tests performed on the apparatus. It should also include the date on which the unit was inspected, the name of the person who inspected it, and the unit number of the apparatus. This record should also note what parts need to be replaced, if any.

Maintenance Records

Visual: Refer to "Visual 12" for a sample maintenance record.

Use this visual as an overhead transparency, chalkboard sketch, or handout.

In addition to the test/inspection record required by Federal law, it is a good idea to keep a separate maintenance record for each apparatus.

A maintenance record should include:

1. The total number of hours the apparatus has been used;

2. The installation date for any new part that has been put on the apparatus;

3. The date on which the apparatus was first placed in service (if known).

A record like this helps you establish a regular maintenance program for each apparatus. This is much like the maintenance schedule that you use for your car. On this record, however, you use "total hours used" as a basis for figuring out what parts should be replaced and/or inspected rather than the car's "total miles traveled."

Note: At this point, discuss your mine's schedule for and/or experience with replacing expendable parts such as hoses, breathing bags, washers, etc.

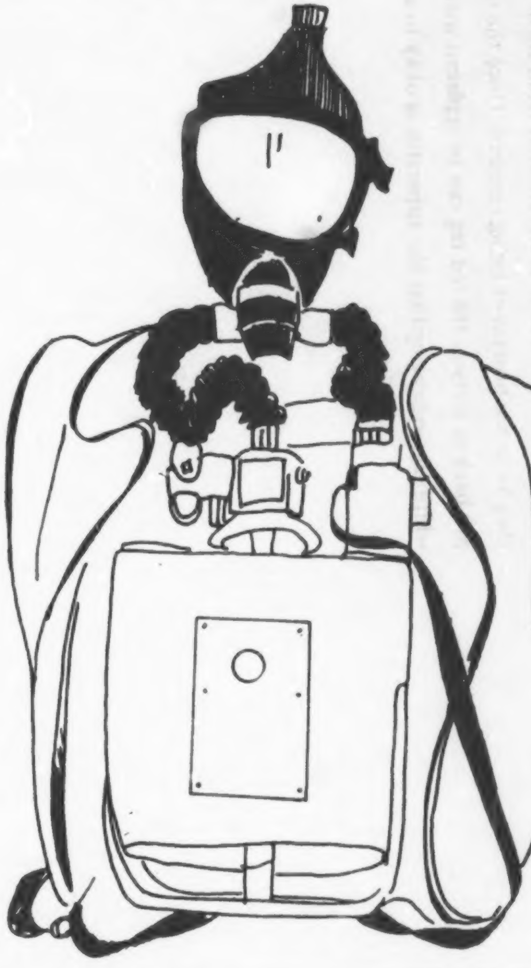
Inspection Tags

Besides keeping detailed maintenance and inspection records, it is also a good idea to keep a record of the unit's last inspection on a tag attached to each unit. Then the person who wears the apparatus next will know when it was last inspected and whether or not it is ready for use without having to look it up on the chart. The inspection tag can be a real timesaver during an actual emergency.

This tag should be placed on the unit every time it is inspected. Along with the date of the last inspection, the tag should include:

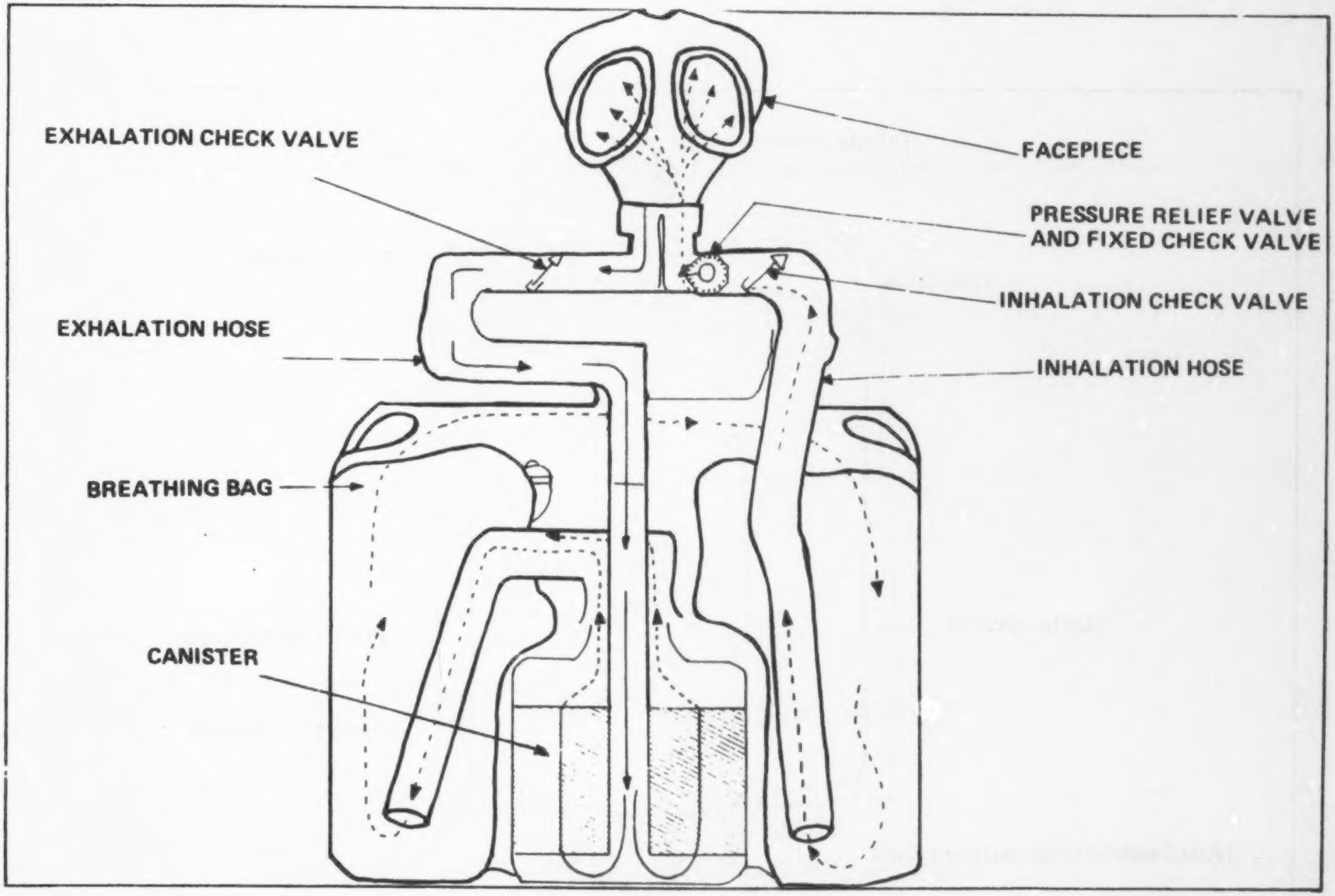
1. The name or initials of the person who inspected it;
2. The names of any parts removed for repairs; and
3. A statement indicating whether the unit is functioning properly and if it is ready for use.

Some mines use red tags to mark units that should not be worn because parts have been removed from them and/or they're in the process of being repaired. Once the unit is put back in service, the red tag can be replaced with a white tag, indicating that the apparatus is okay to use.

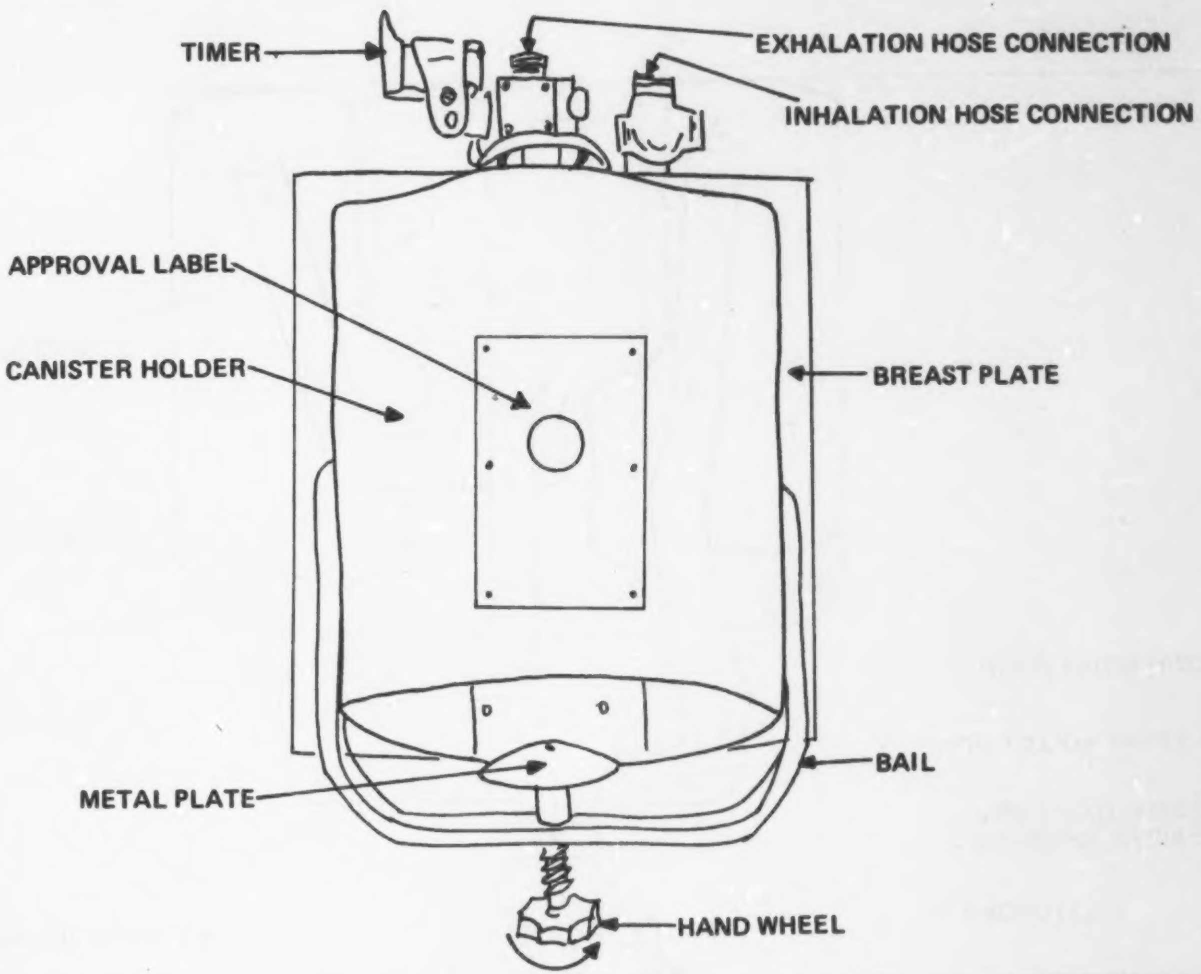


Visual 1

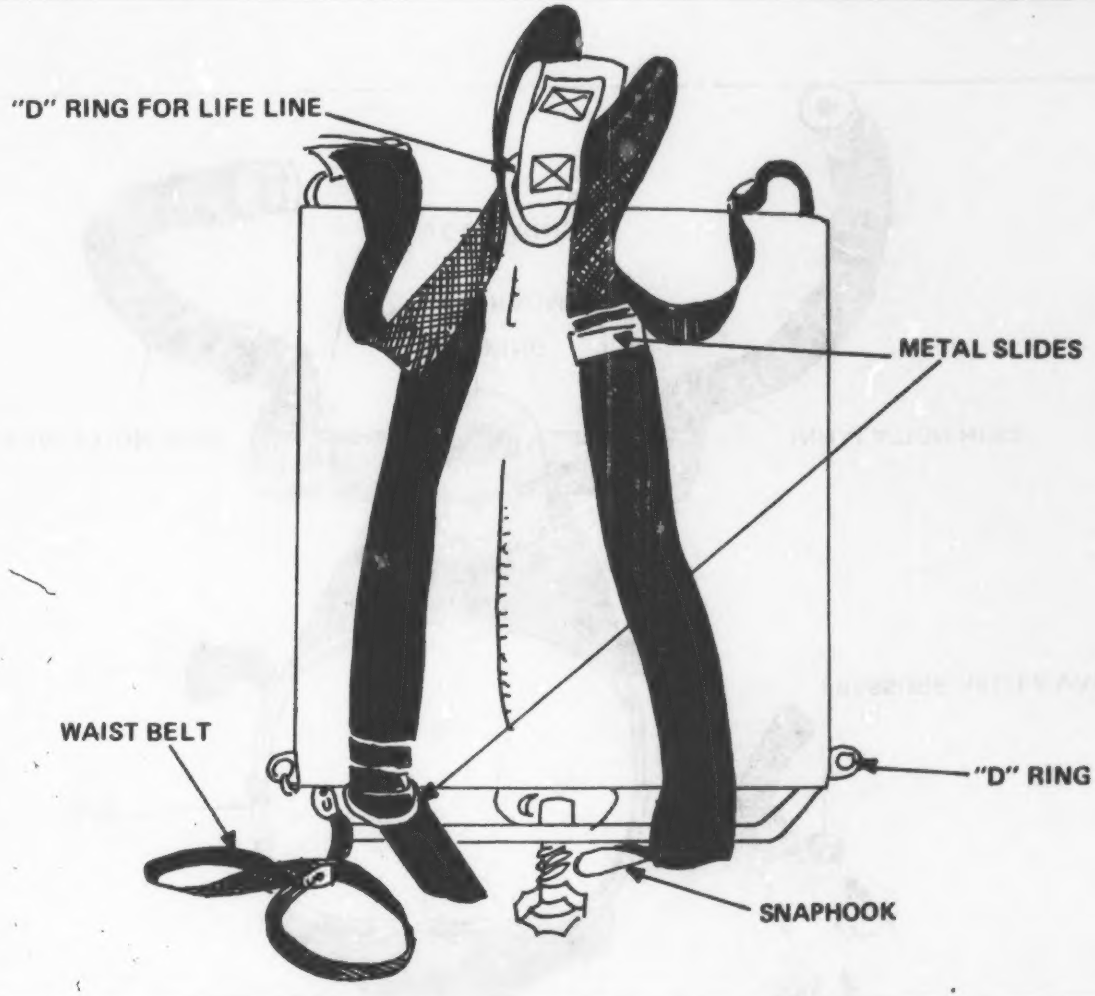
Chemox Apparatus


EXHALATION CHECK VALVE
EXHALATION HOSE
BREATHING BAG
CANISTER
FACEPIECE
PRESSURE RELIEF VALVE AND FIXED CHECK VALVE
INHALATION CHECK VALVE
INHALATION HOSE

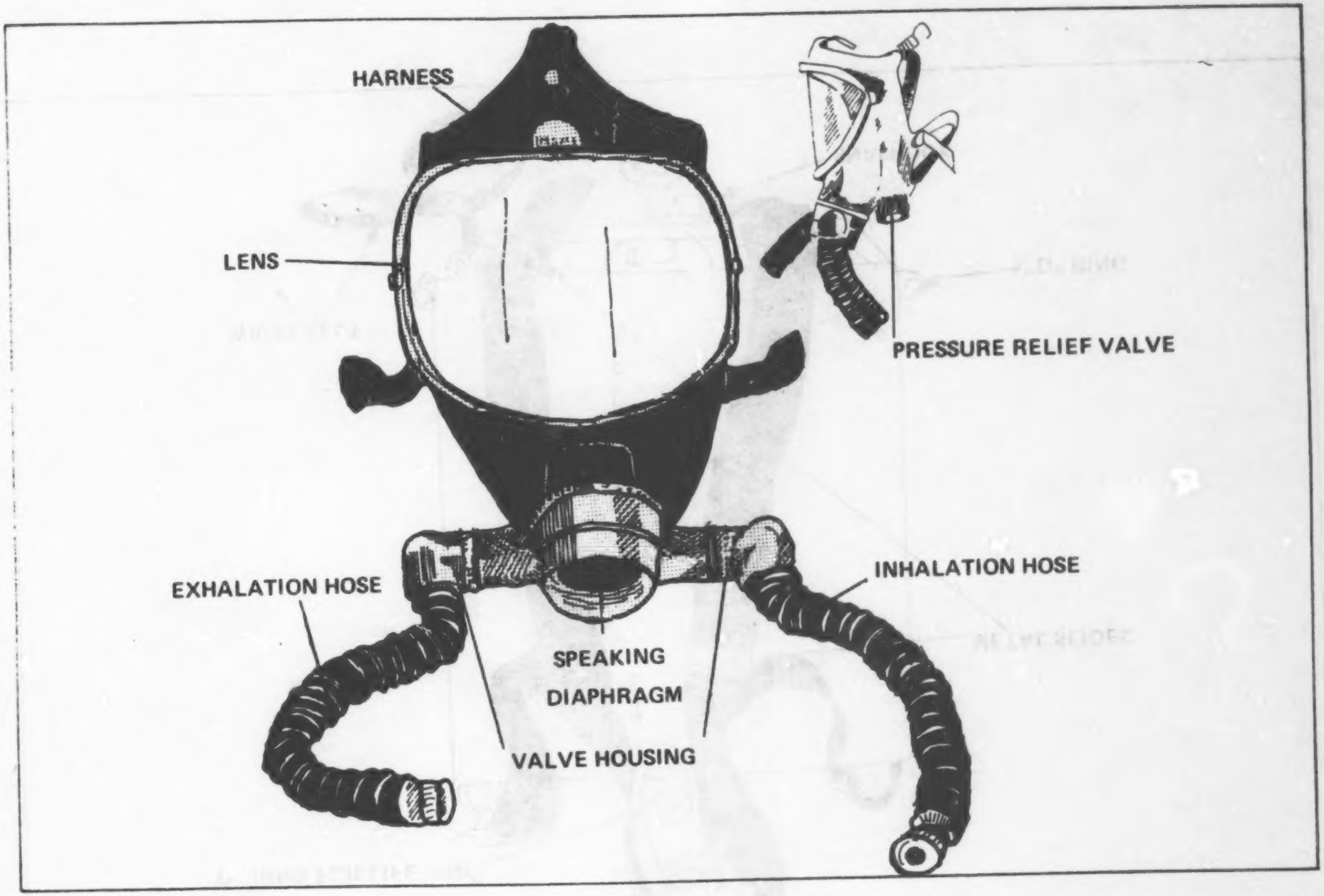
Visual 2 Chemox Parts and Breathing Circuit


TIMER
EXHALATION HOSE CONNECTION
INHALATION HOSE CONNECTION
APPROVAL LABEL
CANISTER HOLDER
BREAST PLATE
METAL PLATE
BAIL
HAND WHEEL

Visual 3 Chemox Breastplate and Canister Holder

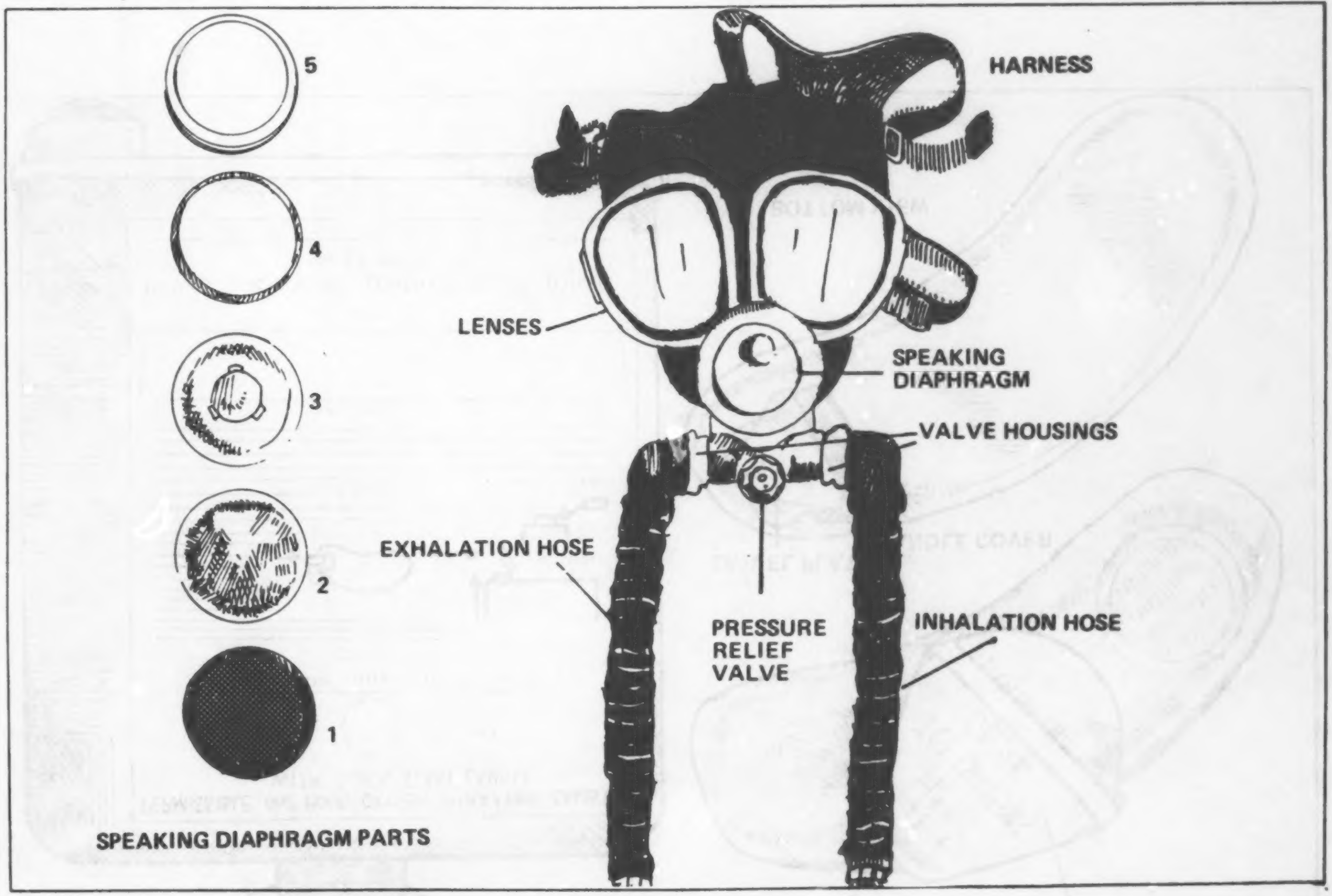

"D" RING FOR LIFE LINE
METAL SLIDES
WAIST BELT
"D" RING
SNAPHOOK

Visual 4 **Chemox Harness**


HARNESS
LENS
PRESSURE RELIEF VALVE
EXHALATION HOSE
INHALATION HOSE
SPEAKING DIAPHRAGM
VALVE HOUSING

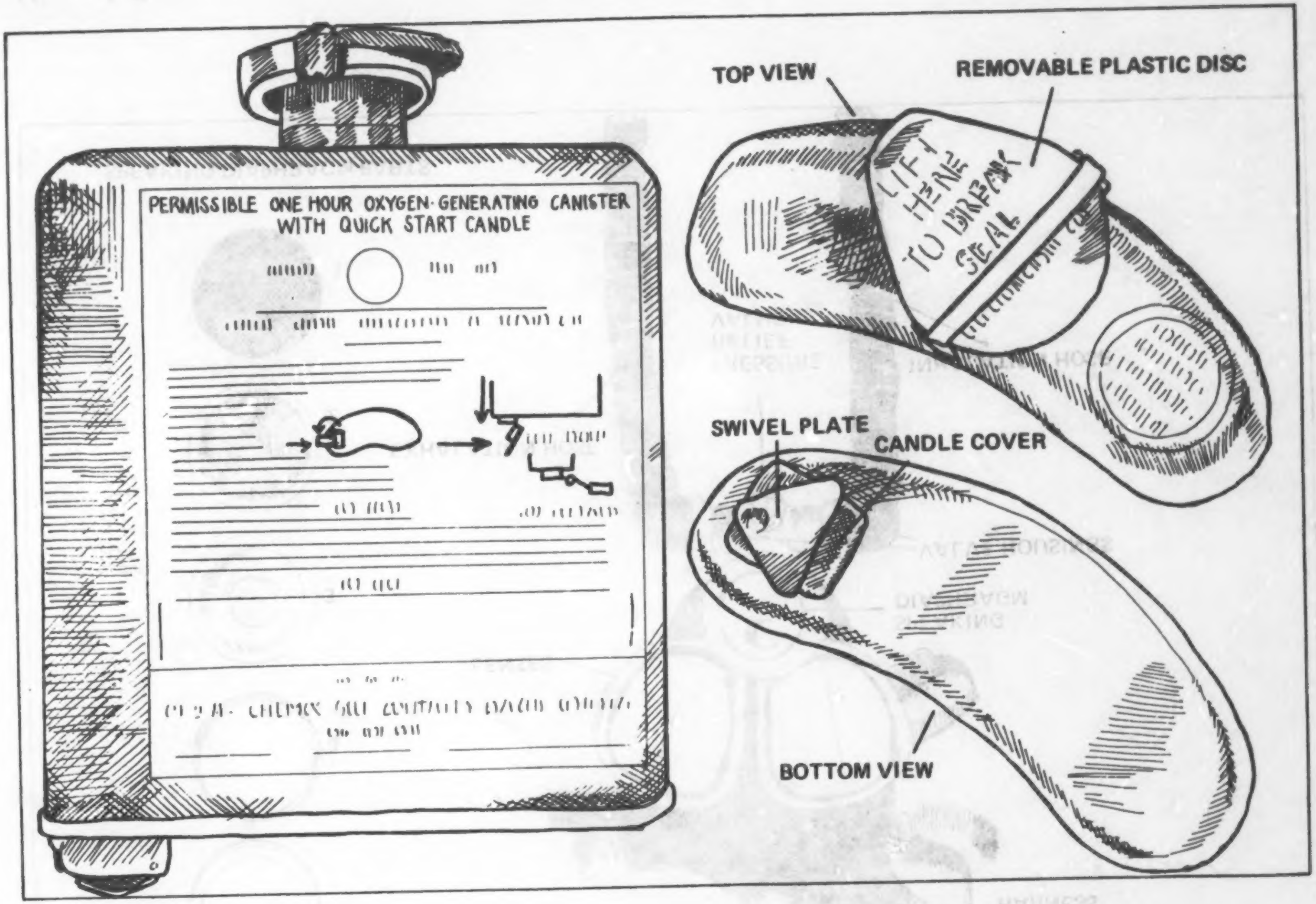
Ultravue Facepiece

Visual 5


HARNESS
5
4
LENSES
3
SPEAKING DIAPHRAGM
VALVE HOUSINGS
2
EXHALATION HOSE
PRESSURE RELIEF VALVE
INHALATION HOSE
1
SPEAKING DIAPHRAGM PARTS

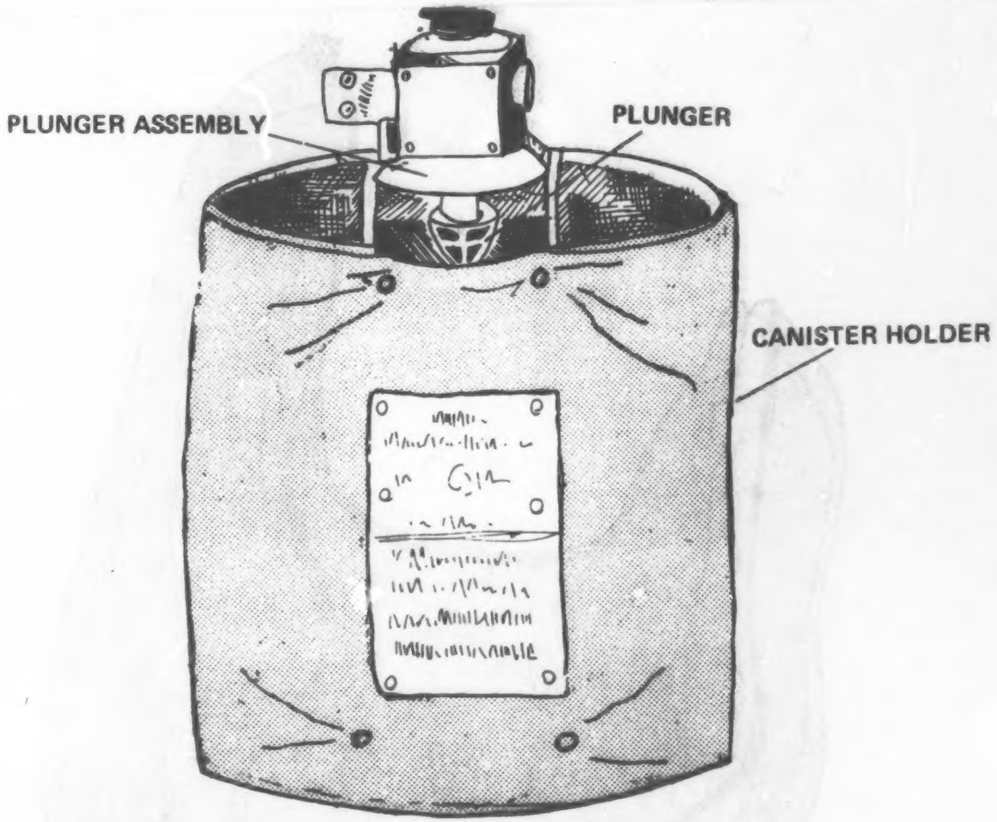
Visual 6

All Vision Facepiece

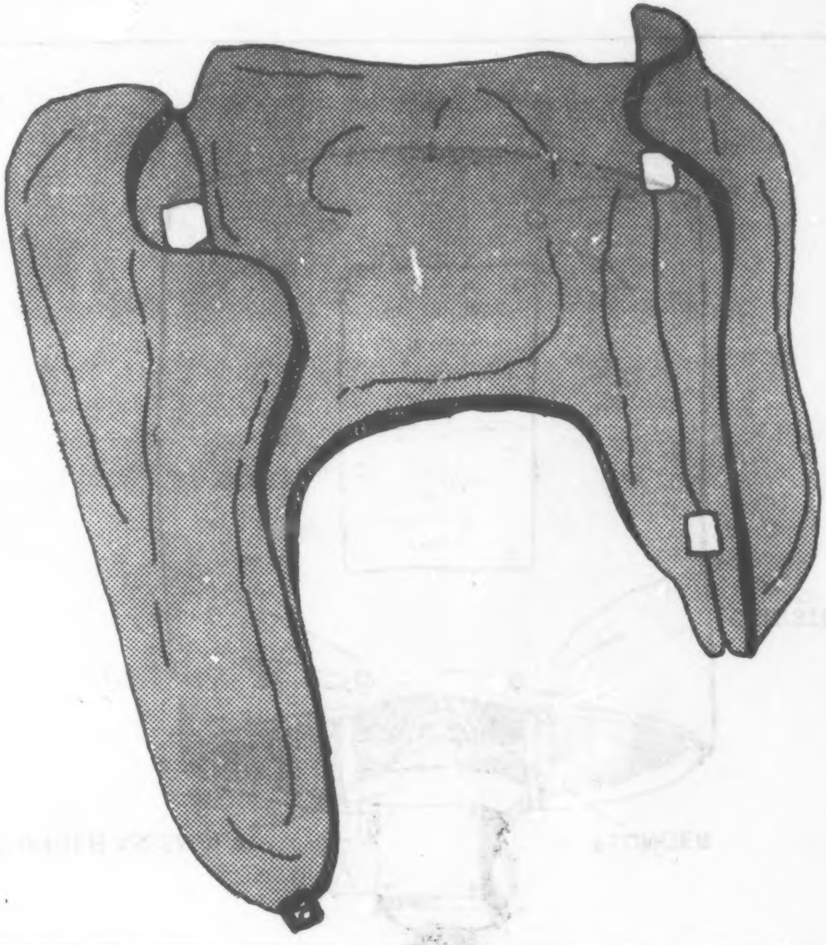

PERMISSIBLE ONE HOUR OXYGEN-GENERATING CANISTER
WITH QUICK START CANDLE
TOP VIEW
REMOVABLE PLASTIC DISC
LIFT HERE TO BREAK SEAL
SWIVEL PLATE
CANDLE COVER
BOTTOM VIEW

Visual 7

Quick Start Canister

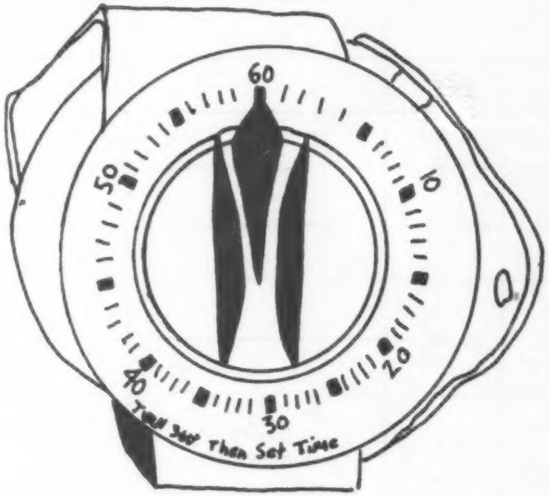

PLUNGER ASSEMBLY
PLUNGER
CANISTER HOLDER

Visual 8 Plunger Assembly



Visual 9

Breathing Bag


60
10
20
30
40
50
Turn 360° Then Set Time

Visual 10 **Timer**

Visual 11

Chemox Sample Inspection Form

No. ____________

Date	Canisters			Visual inspection of rubber and metal parts for deterioration and other defects	Plunger (free moving)	Timer	Facepiece and breathing tubes			Is apparatus in safe condition? (Yes or No and initials)
	How many (3)	Visual inspection (rust, open seams, or seal distortion)	Wrench, anti-fogging agent				Deterioration of rubber parts and gaskets	Examine valves	Examine speaking diaphragm	

Remarks:

READEX FICHE

Visual 12

Chemox Sample Maintenance Record

Apparatus Type: ______________________________ Serial # ________________________

Apparatus # ______________________________

Purchase date ______________________________

# Hours Used	Total Hours Used	Date Inspected	Parts Repaired or Replaced	Comments	Inspected By

Demonstration Check 1

PUTTING ON AND TESTING THE CHEMOX APPARATUS

Person's Name ____________________________

Instruct each team member to demonstrate for you the proper method of putting on and testing the Chemox apparatus. Watch closely as the person goes through the demonstration. Use the checklist below to record the performance.

Inspection

Did the person:

1. Inspect the facepiece and head harness? Yes __ No __
2. Inspect the breathing hoses? Yes __ No __
3. Test hoses for flexibility? Yes __ No __
4. Check speaking diaphragm? Yes __ No __
5. Inspect plunger housing for cleanliness and free movement? Yes __ No __
6. Examine breathing hose gaskets? Yes __ No __

Putting on the facepiece

Did the person:

1. Coat the lens with an anti-fog solution? Yes __ No __
2. Pull the harness down over the outside of the mask? Yes __ No __
3. Put the chin in the bottom of the facepiece and pull the harness up over the head? Yes __ No __
4. Tighten the straps, beginning with the lowest pair and working up? Yes __ No __

Testing the facepiece

Did the person:

1. Test the face-to-facepiece seal by covering the ends of the hoses and inhaling and exhaling several times? Yes __ No __
2. Test the inhalation and exhalation valves by breathing into the facepiece and listening for the noise made by the valves? Yes __ No __
3. Check the pressure relief valve by squeezing the exhalation hose shut, creating pressure in the facepiece by exhaling, and operating the valve? Yes __ No __
4. Test the exhalation valve and the fixed check valve by squeezing off the inhalation hose and inhaling deeply? Yes __ No __
5. Test the inhalation valve and the pressure relief valve by covering the bottom of the exhalation hose and exhaling? Yes __ No __
6. Test the exhalation hose by removing the facepiece and exhaling into the bottom end of the hose? Yes __ No __

Putting on the apparatus

Did the person:

1. Attach hose couplings to the plunger assembly? Yes _ No _
2. Unfasten and straighten harness straps? Yes _ No _
3. Hold the apparatus by the plunger housing with one hand while holding the large "D" ring with the other? Yes _ No _
4. Slip head into web straps and adjust straps properly? Yes _ No _
5. Adjust the apparatus to the proper position on the body? Yes _ No _
6. Attach and adjust waist strap? Yes _ No _

Inserting and starting the canister

Did the person:

1. Properly insert and tighten the potassium superoxide canister? Yes _ No _
2. With a Quick Start canister, start it by:
   a. Put on the facepiece and adjust it for proper fit? Yes _ No _
   b. Removing candle cover to expose lanyard? Yes _ No _
   c. Pulling lanyard out and away from the body? Yes _ No _
3. With a standard canister:
   a. Put on the facepiece and adjust it for proper fit? Yes _ No _
   b. Close both breathing hoses with one hand? Yes _ No _
   c. Break facepiece seal with finger of other hand, inhale, release breathing hoses, and release finger from facepiece? Yes _ No _
   d. Exhale into the apparatus and repeat process until breathing bag is fully inflated? Yes _ No _
   e. Deflate breathing bag by pushing in on pressure relief valve and squeezing bag with forearms? Yes _ No _
   f. Repeat above procedure until canister begins to produce oxygen? Yes _ No _

Testing apparatus functions

Did the person:

1. Squeeze inhalation hose shut with one hand and inhale to test facepiece seal and to check inhalation hose for leaks? Yes _ No _
2. Squeeze exhalation hose shut with hand and inhale and exhale until a leak occurs between face and facepiece? Yes _ No _
3. Tighten facepiece straps if necessary to get a good seal? Yes _ No _
4. Check that breathing bag is fully inflated, then release excess pressure by operating pressure relief valve? Yes _ No _
5. Check lower part of apparatus for leaks by pushing both sides of the bag with forearms? Yes _ No _
6. Properly set the timer to include time required to return to fresh air base? Yes _ No _
7. Synchronize the timer on the apparatus with wearer's watch? Yes _ No _

Demonstration Check 2

MAINTENANCE

Person's Name ______________________________

Instruct each team member to demonstrate for you the proper method of maintaining the Chemox. Watch closely as the team member goes through the demonstration. Use the checklist below to record the performance:

Removing exposed parts

Did the person:

1. Remove the potassium superoxide canister correctly? Yes __ No __
2. Dispose of canister properly? Yes __ No __
    a. Properly puncture canister? Yes __ No __
    b. Immerse canister in water? Yes __ No __
    c. Allow the canister to expend itself in an area that is free of oils, greases, flames, etc? Yes __ No __
    d. Properly dispose of the water? Yes __ No __
3. Remove breathing hoses from the apparatus? Yes __ No __

Cleaning and disinfecting

(Note: It is not necessary that the person actually wash, rinse, and dry the parts. Have the person "go through the motions," so to speak, telling you how to properly wash, rinse, and dry the parts.)

Did the person:

1. Wash the exposed parts in the properly diluted disinfectant solution?
    Parts: facepiece Yes __ No __
    inhalation hose Yes __ No __
    exhalation hose Yes __ No __
2. Thoroughly rinse parts? Yes __ No __
3. Properly dry parts? Yes __ No __
4. Properly wipe down harness and breastplate of apparatus? Yes __ No __
5. Properly place apparatus in storage box? Yes __ No __

Suggested Wearing Schedule

The purpose of this wearing schedule is to give new team members a chance to practice wearing an apparatus–breathing, moving, and working with it on. Also they will practice performing team checks.

The three sessions of the wearing schedule are designed to be progressively more demanding. This wearing schedule is provided as a guide. You can tailor it to fit the conditions at your mine site and the needs of your team.

Prior to any practice procedures that involve wearing SCBA, the prospective mine rescue team member should be familiar with the construction, assembly, testing, and care of the apparatus being used, and should have met the physical requirements for mine rescue team membership as outlined in 30 *CFR*, Part 49.

During the initial training sessions, the instructor should monitor the condition of each member closely. Besides checking each team member's general physical condition, the instructor should be on the lookout for signs of potential trouble like these:

1. Rapid, shallow breathing by trainee (indicates inexperience in breathing with an apparatus)

2. Excessively heavy breathing (indicates trainee is excited)

3. Facepiece fit

   a. Too loose–indicated by:

      (1) Shifting of facepiece during activity
      (2) Failure to maintain facepiece seal

   b. Too tight–indicated by:

      (1) Red marks on face when facepiece is removed
      (2) Trainee complains of headache

4. Rapid consumption of O_2 supply by trainee (indicated by size of breathing bag). If apparatus is functioning properly, this indicates:

   (1) Lack of confidence in apparatus
   (2) Poor physical condition of trainee
   (3) Improper breathing technique
   or
   (4) Excited condition of trainee

TEAM CHECKS FOR CHEMOX

The team should make an initial check when they put on their apparatus and then stop every 15 to 20 minutes thereafter to make checks.

At each rest stop the team member should be asked if he or she is okay and fit to continue the exercise.

A team check should also include the following:

1. Check of timer
2. Visual check of facepiece seal
3. Check that apparatus harness is properly adjusted and has not moved during the exercise
4. Check that relief valve operates correctly

During an *actual* rescue operation the team captain should carry out these checks, and he or she, in turn, should be checked by the co-captain, *but during these practice exercises* each trainee should be given the opportunity to carry out a check of the other team members. This will ensure that each team member is familiar with the steps and procedures included in a team check.

SESSION 1

It is suggested that the first session be held on the surface. This session should serve primarily to introduce the new trainee to wearing the apparatus. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.
2. Walk at normal speed on level ground (for 10 minutes) to allow trainees to become accustomed to the apparatus.
3. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.
4. Walk over obstructed course, or rough terrain, or climb small hills (10 minutes).

5. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

6. Each carry a 30 to 50 pound weight (a bag of rock dust, sand, fire extinguisher, etc.) for a distance of approximately 100 yards.

7. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

8. Walk on level ground until duration of apparatus service time has been completed.

SESSION 2

It is suggested that this session be held underground if possible. Have the team perform a physically demanding task while under oxygen so they will begin to understand the limitations imposed upon them by self-contained breathing apparatus. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Select a stopping (or bulkhead) or other point that they can walk to and inspect (traveling should take about 15 to 20 minutes).

3. Rest 5 minutes, breathing normally. Check apparatus and condition of team members.

4. Perform some physical activity such as loading a mine car with rock dust, sand, timber, etc. or building a stopping (or bulkhead) or other physically demanding activity until duration of apparatus service time has been completed.

5. Return to surface.

SESSION 3 (Apparatus training in smoke and/or further activities without smoke)

During this session it would be helpful to expose the team to smoke so that they can experience working in smoke and wearing an apparatus under conditions of limited visibility.

If your mining operation is such that a smoke bomb can be used safely underground, this is the most desirable situation. If this is not possible, any confined area—old building, trailer, or a structure made of brattice cloth or plastic—can be used as a smoke room.

Only Step 4 of this session is designed for use in smoke. An alternate Step 4 is also supplied if smoke cannot be used. Trainees should:

1. Properly put on and adjust their apparatus and perform an initial team check.

2. Spend the next 15 minutes traveling in conditions that approximate the type of conditions they'll encounter in their mine, i.e. climbing ladders, crawling or duck walking in low roof conditions, walking over rough terrain, up and down inclines, etc.

3. Enter smoke area. Before doing this, the team should stop for a team check. Trainees should pay special attention to their facepiece seals to ensure a proper seal–not too loose or too tight.

Procedures that can be stressed and practiced during the team's time in smoke are:

1. Experiencing the disorientation that can occur in heavy smoke.

2. The use of a linkline or lifeline to keep team members together.

3. Following a rail (or a 2 inch x 4 inch for a substitute rail).

4. Feeling and following the rib or side (or wall in a building).

5. Team communications in smoke.

The exercise should be designed so that the team spends no longer than 20 to 30 minutes in smoke. Team should make verbal team checks as necessary and have a complete team check immediately upon leaving the smoke area.

ALTERNATE STEP 4 (If smoke is not used.)

If you are not using smoke, have the team engage in physical activity related to mine rescue, such as carrying a weighted stretcher or stoke's basket, or carrying supplies or objects, such as lumber, timbers, or rolls of brattice. These should be tasks that require more than one person. This activity should take 20-30 minutes. Have team make checks as necessary.

Instructor's Note: This three-session wearing schedule is intended to introduce the trainee to wearing apparatus under a variety of conditions. In annual refresher training the trainees will be performing advanced rescue and recovery procedures while wearing the apparatus.

General Review

Chemox

Directions: Select the correct answer to each of the following questions.

1. The chemical in the canister that absorbs carbon dioxide and produces oxygen is:
   a. Nitrogen oxide.
   b. Potassium superoxide.
   c. Potassium oxide.
   d. Nitrogen superoxide.

2. In addition to the timer, what other signs indicate that the canister is approaching the end of its service life? (Select two from the following.)
   a. The facepiece lens(es) fog when you inhale.
   b. It becomes difficult to exhale and you cannot correct this by using the pressure relief valve.
   c. The indicator on the canister cap changes color.
   d. The oxygen you inhale becomes very hot.

3. Unopened Chemox canisters may be stored for:
   a. 6 months.
   b. 1 year.
   c. 5 years.
   d. Indefinitely, as long as they're properly sealed and not damaged.

4. What is the service life of a Chemox canister once it is placed in the apparatus and started?
   a. One hour.
   b. Two hours.
   c. Three hours.
   d. Four hours.

5. To properly dispose of a used Chemox canister:
   a. Place the canister in a well-ventilated area for two hours.
   b. Punch holes in the canister and place in a well-ventilated area for two hours.
   c. Place the canister in a container of clear water until all bubbling stops.
   d. Punch holes in the canister and place it in a container of clear water until all bubbling stops.

6. The breathing bag on the Chemox:
   a. Acts as a flexible, external lung.
   b. Cools oxygen generated by the canister.
   c. Holds oxygen produced by the canister.
   d. All of the above.

7. The chemical in the canister:
   - a. Produces oxygen.
   - b. Removes heat.
   - c. Both a and d.
   - d. Absorbs carbon dioxide.

8. The plunger assembly:
   - a. Allows inhaled air to travel down a tube inside the canister.
   - b. Breaks the seal on the canister neck.
   - c. Cools the oxygen produced by the canister.
   - d. Both a and c.

9. The part of the plunger assembly that fits inside the canister should be checked before and after each use to make sure:
   - a. It will not move and is clean.
   - b. It moves freely and is clean.
   - c. The gasket is in place.
   - d. None of the above.

10. Before inserting a canister in the apparatus it should be inspected for:
    - a. Plastic disc, cap, and copper foil seal.
    - b. Cracks, punctures or other openings.
    - c. Loose or deformed seams.
    - d. All of the above.

Answers:

1. b
2. a and b
3. d
4. a
5. d
6. d
7. c
8. b
9. b
10. d

Glossary

bail A hinged bar on the bottom of the Chemox apparatus that holds the canister in place.

lanyard The cord on the Chemox's Quick Start canister that you pull to fire the starting candle.

liter Metric measure roughly equivalent to one quart (1 quart = 0.95 liter).

potassium superoxide A chemical in the Chemox canister which produces oxygen upon contact with moisture in your breath.

pressure relief valve A device designed to release excess pressure that builds up in the apparatus.

speaking diaphragm A thin, flexible disc (usually a part of the facepiece) that vibrates, as in a microphone, to allow transmission of one's voice to the outside while wearing the facepiece.

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